SCIENTIFIC AMERICAN SUPPLEMENT. No. 959

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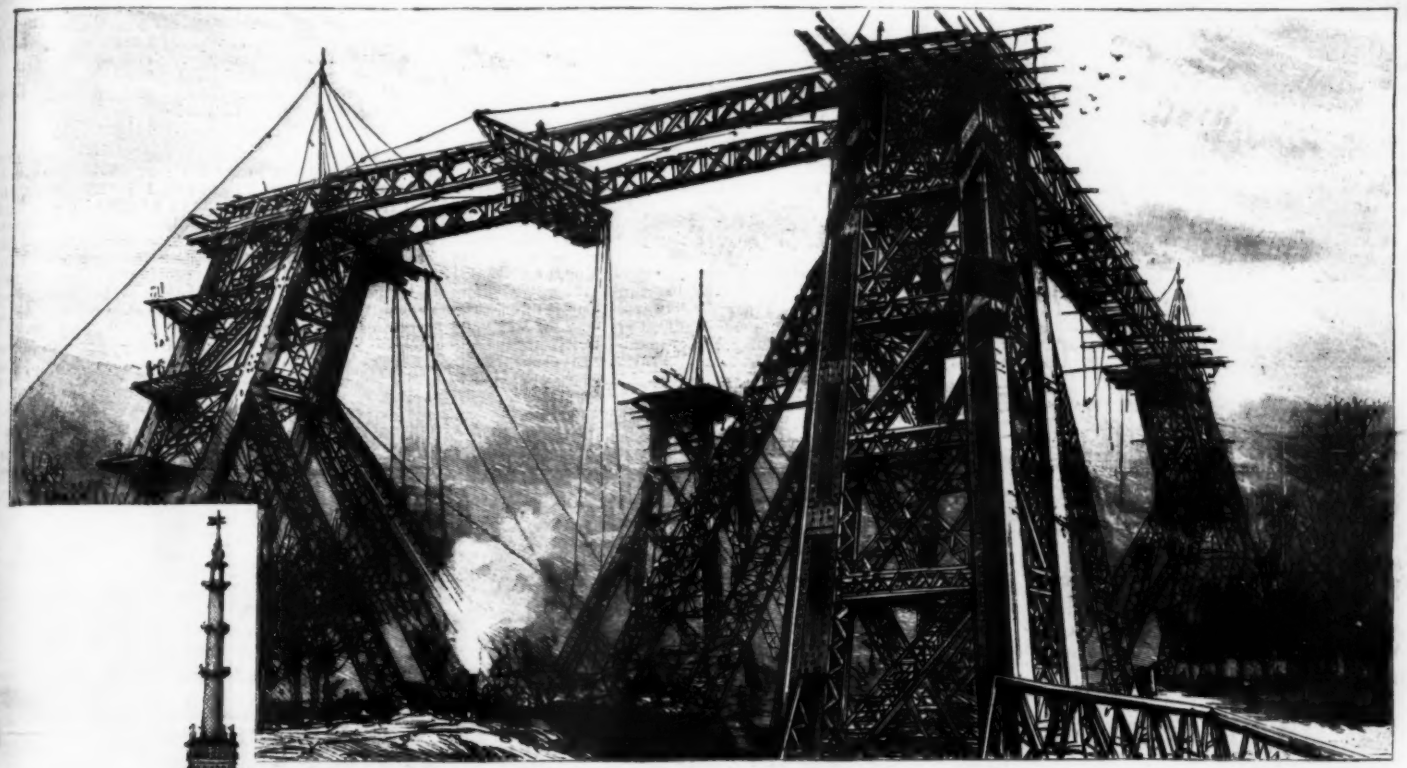
Scientific American Supplement, Vol. XXXVII. No. 959
Scientific American, established 1845.

NEW YORK, MAY 19, 1894.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



WEMBLEY PARK—THE TOWER IN ITS PRESENT CONDITION.

THE TOWER AT WEMBLEY AS IT WILL BE WHEN COMPLETE.

[From the Graphic, London.]

THE GREAT TOWER AT WEMBLEY.

Wembley Park is now in a most attractive guise, and whoever goes to note the progress of the great Watkin Tower will certainly stay to admire its surroundings. One of the finest colonies of rooks near London are busy nesting in the trees in the park, and the early spring has covered the extensive landscape in view from the hill on which the tower is founded with a delicate green, broken here and there with masses of blossom. The Metropolitan Railway trains on their way to Aylesbury and Chesham rattle past, but do not disturb the quiet overmuch, and there is, when the men at the tower have gone to dinner and the hammering has ceased, the pleasant plashing of falling waters to be heard coming from the rivulet which hurries along the bottom of the park. This is from the little River Brent, which has been broadened out into a lake of eight acres. A couple of bridges have been built—one of the ornamental order, upon which sentimental pairs may linger and listen to the waterfall which is below it; the other is built for use, and over it the visitors will pass into the park. Boats are to be placed on the lake, and on one of its three little islands will be a small kiosk. The chief attraction, however, is the cricket and football ground, surrounded by a fine cinder path, which is the largest in the country, having only two laps to the mile, with a finishing stretch of 350 yards "on the straight." As for the park generally, it has been effectively laid out in curving pathways, with shrubberies and flower beds. The fine trees in the park have been preserved as far as possible. A little glade in the northeast corner at night will be lit up with fairy lamps, and concerts in the open air will be given in fine weather. About twenty thousand pounds have been laid out on the buildings in the park. They include restaurants, grand stands, a big shelter for wet weather, band stands, tea pagodas and pavilions. These are attractions enough apart from the tower, which is now rising toward the sky.

Over a hundred and fifty men are constantly employed in putting the tower together, and they are making rapid progress. The foundations have been down a long time, and have quite settled. The first stage is also practically completed, and already the tower is difficult to lose sight of when one is anywhere in the neighborhood of Harrow. Progress has been very steady, and there have been no delays by accidents, or any unforeseen difficulties to be met. The tower is designed by Mr. A. W. Stewart, but some of its details have been modified since Sir Benjamin Baker and Mr. Stewart took the work of erection in hand. Sir Edward Watkin secured the design, it should be said, in response to a prize he offered for such a tower. When the design was selected it had eight legs. These they have now reduced to four, but really the

THE EIFFEL TOWER.

base consists of four groups of four legs each, and each leg rests on its own concrete foundation. It is nearly two years since Messrs. Firbank put in the foundations. The building of the tower above foundation level is being done by Messrs. Heenan & Froude, of Manchester, who are not without experience in such work. They were the builders of the tower, 500 feet high, at Blackpool.

Mild steel is the material used for the mighty structure. We give two sketches which will enable the reader to understand how much higher the Watkin will be as compared with the Eiffel Tower at Paris. The tower will somewhat resemble the one at Paris, but the arrangement of lifts will be different. There will be four lifts. Two will ascend to the height of 150 feet only, and two will go up to 900 feet. They will be all independent, and will be driven by winding engines. At Wembley Park there is not the same necessity as at Paris to have an open space under the tower, so that vertical lifts can be used. These will travel more quickly than if they had to pass up one of the legs. There is the further advantage that the lift guides will stiffen the structure and help to support the first platform, thus enabling lighter girders to be used.

Details of such matters are rather dull reading, but to show what is involved in the erection of such a lofty structure we may give a description of a base. Each base piece weighs ten tons, and stands on a sole plate 9 feet by 7 feet 6 inches, and three-quarters inch thick. Then seven 12 inch by 6¼ inch joists three-quarters inch thick are riveted to the plate, and on these is another plate of the same dimensions. Joists have been let into the concrete on which the bases rest, so that, if necessary, they may be moved slightly for the purposes of adjustment. There might be a risk of the leg slipping bodily forward during erection. To prevent that the bottom sole plate has riveted to it a 4½ inch by 4½ inch angle of steel five-eighths of an inch thick. The base pieces are held in position by bolts 2⅛ inches in diameter, with a three inch thread and a length of thirteen feet. Above the brace pieces the legs are in 26 feet lengths braced together by cross and diagonal girders. Each of these sections weighs seven tons, and is constructed of plates 7-16ths of an inch in thickness. The angles are 4 inch by 4 inch of half-inch thickness of metal. The horizontal and diagonal bracing girders are square in section and connect the legs at every second length, at distances of 52 feet. The extreme width of the tower from outside to outside of the legs at the ground line is 406 feet. The heaviest pieces in the tower are now erected. Our artist has sketched one of them as it was prepared for lifting into place. It is one of the main girders at the first floor level, 146 feet from the ground. It weighed 40 tons, was 140 feet long, and was lifted in one piece. It should be said that all the material is brought to the site by railway, and lines run to each of the four legs. A steam winch has hitherto done all the raising with "shear legs" 65 feet high at each tower leg. The erection will be continued by means of four electric cranes. These weigh about 20 tons, and will run on special girders bolted by the side of and just above the horizontal struts. The cranes will unload direct from the railway trucks, and as each section is finished they will be able to lift themselves to the next level in twenty-five minutes. One central or generating dynamo will serve for all four cranes. It will only work one at a time, but will have sufficient spare power for some electric drills. After the tower reaches the height of 500 feet, only one of these cranes will be used. It will be provided with a longer jib, and will be in the center sliding between the lift guides. One figure more. When completed, the total weight of the tower is estimated at 7,000 tons!

The total height of the tower when completed will be 1,150 feet, that of the Eiffel Tower being 975 feet. The Watkin Tower stands on an eminence 165 feet above sea level, and at this tremendous height it is difficult to form an idea of the wide stretch of country which will be under foot and within sight. The lifts will carry 60,000 people a day. As for the uses to which the tower will be put some day depends on circumstances. On the first platform, which is 160 feet from the ground, and is about 200 feet square, shops, restaurants, side shows, and a concert hall will be built. The second platform will be at the altitude of 500 feet, and this will contain similar buildings to the lower platform, but on a smaller scale, as the space at command will be much less. Higher still a third platform will be built, and on this will be a post office, a telephone call office, and other small buildings. Right at the top will be an observatory and a very powerful electric light, from which the beams should be seen from great distances. That on the Eiffel has been seen seventy miles away. The tower is expected to be finished next year, and will cost £200,000.

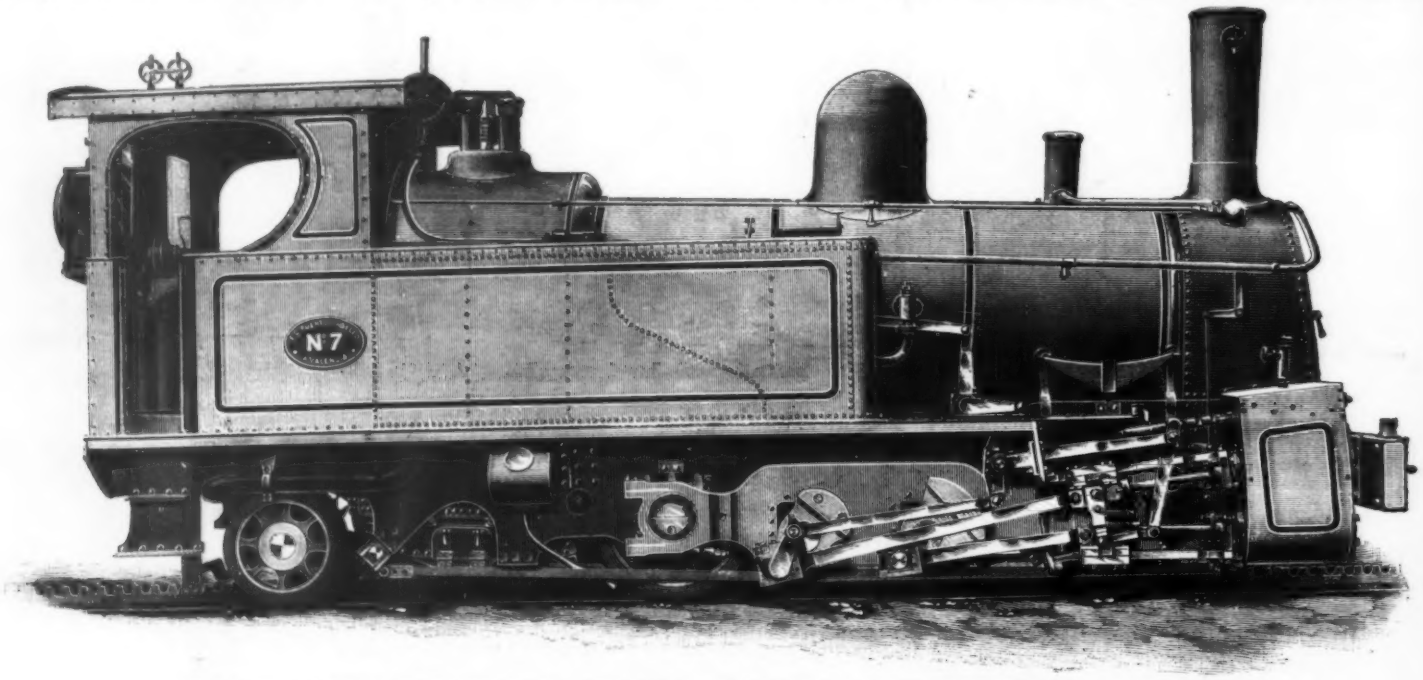
Interesting as the tower may be, a much prettier sight is the country round it. One is only six miles from Baker Street, yet the lanes leading to Harrow or to Kingsbury, with their wealth of trees, might be in some distant part of Kent. By the way, too, close to the park gate at Wemoley, and actually on the property of the company, which is here appealed to to spare them, are three of the most picturesque cottages to be found anywhere about London. One of them serves as a lodge. Its roof is thatched, and it is covered with ivy, and it has attached a structure for containing beehives quite in the old-fashioned way. Almost adjoining the lodge is a still older-appearing cottage with gables and dormers. Immediately opposite is a partly half timbered farmhouse, almost concealed behind a luxuriant growth of ivy. Thus at Wembley you may contrast the structures which contented our forefathers and those which but ill content us. For who will say the Watkin Tower is final?

IMPROVED RACK LOCOMOTIVE.

IN a paper read some time back before the Institution of Civil Engineers on the Puerto Cabello and Valencia Railway (Trincheras Incline) by Mr. J. Carruthers, M.I.C.E., a short description was given of the locomotives designed for use on the incline. Ample experience of the working of these engines during the last six years having been obtained, it may be of interest to give leading particulars of their design, the amount of work they are doing, and cost of haulage. The engines were designed and constructed under the patents of Messrs. H. Lange and H. Livesey, by the firm of Beyer, Peacock & Co., in 1887, and a general elevation of them is given above. It will be seen that the general design of the locomotive is that of a side-tank engine, having two pairs of carrier wheels, which in an ordinary engine would be the driving and leading wheels, together with a trailing two-wheeled bogie. The boiler is of the usual locomotive type, but as will be seen from the figures given below, is of large dimensions in proportion to the cylinders; the shell of the firebox and barrel is of steel, the firebox of copper, and the tubes brass; it is fed by two injectors, and is worked at a pressure of 150 pounds per square inch. In order to accommodate the water level as far as possible to both the level line and to the extreme grade on which the engines work, the boiler is not fixed horizontally on the frames, but at an angle of 1 in 24. The engine is designed to work on a central rack rail, and has no power of propulsion when on an ordinary track, the wheels being carriers only. The motive power of the engine is transmitted through two cog wheels placed between the two carrier axles and mounted on two axles which revolve in bearings carried by frames on each side of the engine, fixed to the axle boxes of the carrier axles. It will thus be seen that rather more than two-thirds of the total weight of the engine, resting through the bearing springs on the axle boxes of the carrier wheels, is utilized to prevent any up-thrust from the working of the cog wheels in the rack. At the extremity of each cog axle is attached a fly crank connected with the steam cylinder in the ordinary manner. The cog wheel axles are each worked by a separate pair of cylinders, and are not connected together by coupling rods in the usual way. By this arrangement each cog wheel must of necessity perform its proper share of the work, no matter how great the inequality of the rack; and although four cylinders are required, they are worked by two sets of valve gear of the Walschaert type actuated by a return crank on the hind motive axle. The engine is fitted with three independent brakes, namely, two powerful hand-screw brakes, one acting on the four carrier wheels, and the other upon grooved drums fitted to each side of the cog wheels; the third is an improved counter pressure air brake acting upon the pistons. This brake is used in descending the incline, and not only saves the wear and tear upon the tires and rails, but also that on the cylinders caused by the products from the smoke box, which would be drawn into the cylinders when the steam is entirely shut off. The principal dimensions of the engine are as follows:

Cylinders (four)	11¼ in. in diameter by 18 in. stroke
Cog wheels (two)	2 ft. 1⅞ in diam. on pitch circle
Carrying wheels (six)	Four front wheels, 3 ft. 6 in. in diameter, on fixed axles; two hind wheels, 2 ft. 6 in. in diameter, on a bogie axle
Length of rigid wheel base	8 ft. 9 in.
Total wheel base	16 ft. 10 in.
Tractive power per pound pressure on piston area	178·6 pounds
Working boiler pressure	150 pounds
Heating surface	1,167·5 sq. ft.
Grate area	17·5 sq. ft.
Capacity of tanks	540 gallons
Capacity of bunker	19 cubic feet
Weight of engine in working order	40 tons

The incline on which these engines work commences at Trincheras station, 1,188 feet above sea level, and rises with grades of 1 in 21 and 1 in 28 for 4,000 feet, and then a continual grade of 1 in 12½ for a distance of 7,700 feet, when the summit is reached, the length of the incline being 2¼ miles. The curves are of 500 feet radius, the gauge of the railway being 3 feet 6 inches. The rails are of flange section, weighing 55 pounds per yard, and are fixed to steel transverse sleepers, in the center of each of which is bolted a cast iron chair, carrying the rack, which is of the "Abt" type. The incline is situated midway between the seaport of Puerto Cabello and the terminus at Valencia, and the trains are brought by ordinary adhesion engines to and from the incline on either side, the rack engines then taking their place. The trains consist usually of four bogie wagons, each loaded with 10 to 11 tons of merchandise, or a total gross weight, exclusive of the locomotive, of 70 tons, the rack engine being always placed at the lower end of the train.—*Engineering.*



RACK RAIL LOCOMOTIVE, PUERTO CABELLO AND VALENCIA RAILWAY.

THE BROADWAY CABLE, NEW YORK.

IF one stands astride the narrow slot which is, as it were, an artery through an artery of our great city, on Broadway, and watches the snaky cable as it glides along, he must pause a moment to consider before he can realize what an enormous amount of power it carries and what experiences it has to go through. Cruelly gripped by the mechanism beneath the cable cars and straining as it passes over curves, it has indeed a hard road to travel. What stories it could tell!

Before we tell the history of the cable, let us see of what it is composed. A strong hempen strand five-eighths of an inch in diameter forms the inner core; around this are wrapped six steel cables, which are in turn composed of seven strands wrapped around with other strands of steel wire, the whole making a total diameter of one and one-half inches.

A steel rod three-eighths of an inch in diameter and one foot in length weighs approximately one pound. The difference in weight between this cable and a steel rod of the same size may be realized when it is known that this cable weighs but three pounds to the running foot. The use of the central hemp rope is for the purpose of giving a certain pliability.

In order that rust and decay should be avoided, the rope is kept smeared with tar and oil. This is what causes the black, shiny appearance. As one of the cables which obtains its power from the Broadway cable house is 20,000 feet in length, it is not difficult to determine the entire weight, which in this case would be 60,000 pounds. The market price of cables being about 40 cents per foot, the cost of this would be in the neighborhood of $8,000 for one coil of wire. The Broadway company maintains six cables, and as the

approximate life of a cable in our busy thoroughfare is little more than eight months, it would appear that the expense caused by the renewal of cables is not a small item. In Denver, Col., longer cables than these exist, the one on the main street being 36,900 feet in length, having a diameter of but one inch and a quarter. Owing to the fact that there is less traffic in the latter city, the work required from the cable is not so great. Its life is slightly lengthened, and ten months may be put to its credit.

It is quite interesting to watch the peculiarities of the cable, and when we stop a moment to think how the gripmen when they reach the termini of a line have the destruction of $8,000 worth of property in their power, we can see that some means is yet to be devised which will perform automatically the action of throwing off the grip, for unless the grip is loosened as the car approaches the power house, when it reaches the place where the cable descends to the driving wheels something must give way, and while the cable generally has the best of the encounter, very often a couple of strands are ripped, which entails considerable work upon the repairers.

At the Broadway power house, Mr. M. Moore is the person who is technically known as the "splicer." He was brought from Denver, where he had been in charge of the cable in that city. He has about eight or ten men under him, who, with dexterity, make necessary repairs.

Cables are in a measure human. They have their diseases and they need their doctors. Mr. Moore is the medical examiner, and from him we received several points concerning the troubles to which the cable is subjected.

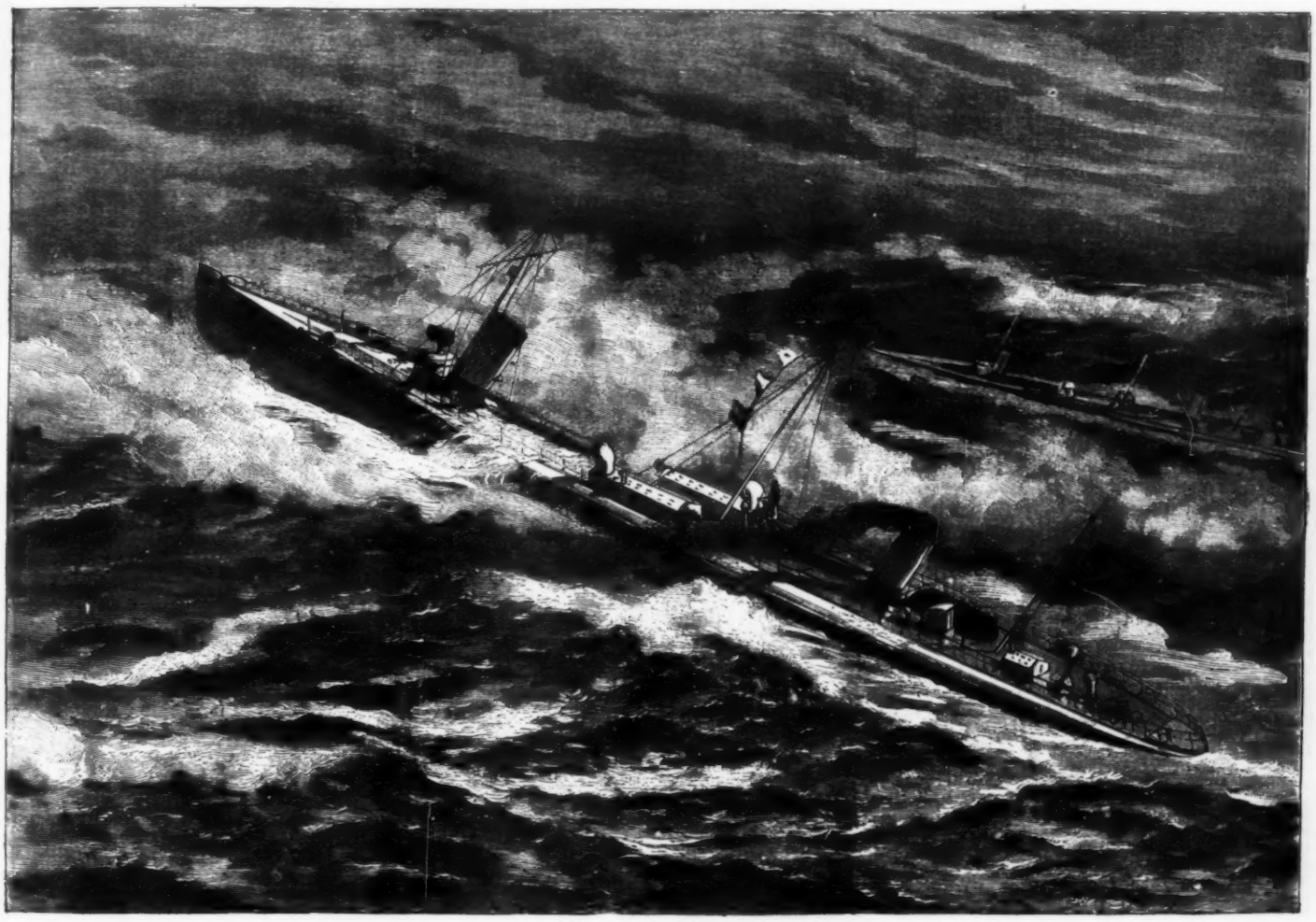
In case a cable has become bent in any way, it is difficult, in fact almost impossible, to straighten it absolutely. The bend remains, and if we stoop down to watch its onward approach it looks like a huge sea serpent, wriggling toward you, performing wonderful gyrations as it approaches. Several of these "kinks," as they are termed, have been made in the up-town cable, which travels at the rate of 810 feet per minute. As the rate of the cable is invariable, by simply looking at the clock, the man whose sole duty it is to watch the cable can tell at exactly what place the "kink" is situated. As a matter of curiosity we inquired of the watcher at the Sixtieth Street power house when the next "kink" would arrive. Looking at his watch and hastily making a mental calculation, he answered, "Between 4:11 and 4:12." In fact, the "kink" came in sight immediately as the hands of the watch pointed to eleven minutes after four.

With the Bowling Green cable, however, few "kinks" occur. The line is straighter and does not run under dangerous curves like those at Fourteenth and Twenty-third Streets. It might be well to mention here that, unless the grip is held fast to the cable as the curve is rounded, the enormous friction, resulting from the slipping of the cable through the grip at this point, would be sufficient to "burn" the strands or grind the grip; in either case doing considerable damage.

While it is easy to localize accidents, it is difficult to assign causes. However, recently, for some reason or other, the Bowling Green cable had about 1,000 feet of strands ripped off, and the writhing, curling mass of wire, as it lay upon the floor of the power house, presented a most confused appearance, and one would be led to wonder how puny man could have the power to cope with such an apparently unwieldy mass. With huge shears, however, those pieces of metal are snipped off, and a new cable must be put in place of the damaged portion. The splicing is an interesting operation. Unlike rope, the strands are extremely difficult to manipulate; yet, with skill acquired from the continual work, each strand is woven into place among other strands, heavy pliers and marlinspikes being used to separate the layers. When all is done, about four inches of the ends of each strand are left outside the cable, and by continued wear they finally break off and the splice becomes practically as a virgin cable. Even the trained eye of Mr. Moore is unable to detect the splice after the wires have been thoroughly covered with tar. The joint is as firm and as strong as the original cable.

Delicate hands are out of place in this work, and cable splicers are veritably "horny-handed sons of toil." Their work is done mainly in the wee hours of the night, when traffic is at its minimum. Mr. Moore assures me that with his eight or ten helpers he can splice in a thousand feet of cable in one hour and a half.

At the Broadway station, far down underground, in regions damp and dripping with steam and tar, one may see the tension carriages, which play backward and forward on their slimy beds, with the restraining forces of the cable in one direction and the tension weight of 4,400 pounds in the other. Everything is oil and tar, but the atmosphere is kept reasonably pure by a huge ventilating fan. Around and around the ponderous wheels revolve; onward glides the snaky cable, and, with eyes ever alert for approaching danger, the tireless watcher sits and waits for kinks or broken strands.—*Electrical Review.*



THE NEW BRAZILIAN TORPEDO BOATS.

THE NEWEST SCHICHAU TORPEDO BOATS—BUILT FOR THE BRAZILIAN GOVERNMENT.

THE firm of Schichau, of Elbing, has gained a world-wide reputation on account of the great speed of its torpedo boats, but lately it has given new evidence of its ability as a shipbuilding firm by adopting a new method of construction, by means of which boats have been produced that are even faster than those formerly made by this house. We refer to the five torpedo boats recently purchased by the legitimate Brazilian government, which, when fully equipped, developed a speed of 28 knots an hour on the trial trip, showing them to be the fastest vessels in the world. They are each 152 ft. 6 in. long between the perpendiculars, and the double screw is driven by two three-cylinder engines, that develop 2,200 horse power, the steam for which is generated in two locomotive boilers. These little boats had to cross the ocean in severe winter weather, so as to reach their destination, Pernambuco, Brazil, as soon as possible. One would suppose that, under such circumstances, it would be difficult to get officers and men, but the confidence in the vessels and the engines was so great that enough men were found to bravely undertake the hazardous task and carry it out successfully.

It would have been interesting to accompany these bold seafarers on their voyage. Each of the five boats was provided with a tried captain, a pilot, and fifteen men. The last of November they left Pillau for Kiel, where they were thoroughly equipped for war, and then they passed through the Elder Canal to the North Sea. Both there and in the Channel they experienced very stormy weather, and were detained at Dartmouth two weeks by a hurricane. Boats One, Two, and Three started from here December 26, steering in a direct line for Las Palmas. In the Bay of Biscay they had to pass through a severe test, for a westerly storm drove the waves as high as a house, boiling foam and crushing breakers dashed over them, but they proved to be entirely seaworthy, passing through the flood as smoothly as an eel, and plunging with a graceful motion from the crest to the trough of a wave. There was no warm food for the crew while the storm lasted; cooking could not be thought of when there was such terrible motion, and for days a piece of bread and a swallow of brandy was the only nourishment taken. The boats reached Las Palmas in good condition, and they were kept in quarantine four days. Then they went to St. Vincent, where they had to remain in quarantine five days more. From there they steamed across the Atlantic to Pernambuco, where they arrived January 19, in good condition.

Boats Four and Five left Dartmouth on December 31, and followed in the course taken by the others. They were quarantined in Las Palmas for one day, and at St. Vincent for eight days. On January 26 they also reached Pernambuco in good condition. During the entire voyage only one boiler was used at a time, the boats making a speed of 16 knots. After a brilliant trial, the five boats were accepted by the Brazilian government.

The great confidence felt in Germany in the Schichau boats is shown by the fact that the insurance companies insure them at 1½ to 1¾ per cent., while the English companies demand 4 to 5 per cent. on English vessels.—*Illustrirte Zeitung.*

LIQUID FUEL AT SEA.

IT has often been asked why it is that steamers carrying some thousands of tons of petroleum in bulk should fill their bunkers with coal. Although it is true that petroleum in any but the crudest form is an exceedingly expensive fuel if purchased in England, it is not necessarily costly if bought on the Black Sea or in the United States. Indeed, unless a steamer carries coal enough for the voyage out and home, petroleum would not compare very badly with it if bought in a Black Sea port. In South Russia coal for railway purposes costs from £2 10s. to £3 per ton, and petroleum has been substituted for coal by Mr. Urquhart with very great economy. On the Black Sea and the Caspian ply dozens of steamers using liquid fuel. There is no lack of precedent, yet in the mercantile marine liquid fuel has up to the present found no place. Considerable interest under the circumstances attaches to an experiment now being made by Mr. A. Suart of London. He has fitted a large tank steamer, the Baku Standard, with appliances for burning astaki, and she recently completed a voyage to Philadelphia from Shields, burning only liquid fuel. She then made a return trip to this country, and has since sailed again. So far as we are aware, this is the first instance on

record of a steamship fitted to burn liquid fuel and making an ocean voyage. Hitherto there has always been a breakdown of some kind during the trial. The Baku Standard registers 3,705 gross tons, she is 330 ft. by 43 ft. by 23 ft. deep. She carries 1,200,000 gallons of petroleum in bulk, and goes to Russia as well as the United States for oil.

When we come to consider particulars, it will be seen that the Baku Standard made her voyage under difficulties; instead of the usual crew of firemen and trimmers, only three boiler tenders were shipped. One met with an accident soon after the ship sailed, breaking a collar bone, and was laid up. The result was that the other two men had to stand six hours watch and six hours watch on the rest of the voyage, which they could scarcely have managed if they had had to work hard shoveling coal and cleaning fires. As a fact, however, the fires seem to have needed little or no attention, even in the worst weather, and so far the venture has been quite successful. The consumption of oil was about 20 tons in the twenty-four hours. Taking the oil as being twice as good as coal, this means 40 tons of coal a day, and with good triple expansion engines, this should give 2,500 indicated horse power. The engines of the Baku Standard, however, do not indicate anything like this, and we shall perhaps overestimate the efficiency of the astaki fuel if we say that 20 tons of it were equal to 30 tons of coal, which would give 1,500 to 1,800 horse power. No doubt the cost of astaki was greater than that of coal, but against this must be set the greatly reduced cost of the fire room crews—so many fewer mouths to be fed, and so much less wages to be paid. So far Mr. Suart seems to be contented with the result in all respects but one, and that is the old trouble that has arisen over and over again when petroleum fuel is used in conjunction with surface condensing engines. A very serious quantity of steam is used in "spraying" the astaki. This represents so much waste, but that is by no means the worst of the matter. The steam thus drawn off from the boiler goes into the chimney in one form or another, and the auxiliary feed has to be employed to make up the loss. Salt water cannot be pumped into the boilers, fresh water enough cannot be carried, and consequently an expensive and heavy evaporating plant must be fitted and worked with liquid fuel. It is very easy to underestimate this item; when we say, however, that during the first voyage of the Baku Standard the weight of steam required to spray the oil exceeded that of the oil, reaching to over a ton an hour, some idea may be formed of what it represents in the way of loss. Allowing 20 lb. of steam to give a horse power—a very ample allowance for a good triple expansion engine—we see that a ton of steam per hour means about 112 indicated horse power; and allowing that 1 lb. of astaki will evaporate 15 lb. of water, it means that not less than 3,600 lb., or over a ton and a half of astaki, had to be burned every twenty-four hours for the purpose of supplying fresh water to the boilers. This represents a very considerable addition to the cost, and it certainly seems strange that considerably over 100 horse power should be required to force the fuel into the furnaces. We understand that a different set of burners is now being tried, and it is hoped that the auxiliary feed required will be reduced from 25 tons to 10 tons per twenty-four hours.

There remains for consideration the difficulty involved in handling the petroleum. In the Baku Standard as at first fitted the stuff was pumped up from special bunkers into two small tanks in the funnel casing, where it becomes more fluid than water, and from these tanks it ran down to the furnaces through suitable pipes. It appears that this arrangement has had to be modified. There is great difficulty in dealing with the oil in the bunkers when they get partially empty. It is well understood that oil tanks should always be kept quite full. There is absolutely no danger of an explosion when air is kept out; the difficulty is to prevent the accumulation of an explosive mixture of air and petroleum vapor in the bunkers when the level of the air falls in them. It is very easy to say that means of ventilation can be provided; not so easy to do it. The bunkers in the Baku Standard are insulated from the boilers by cofferdams filled with water; but the two service tanks cannot be so insulated, and if they leaked, or any of the pipes or fittings, there would be a serious risk of fire incurred. We believe that two other vessels belonging to Mr. Suart are to be altered to burn liquid fuel; so that the experiment, it will be seen, is being carried out on a scale commensurate with its importance. "Lloyds," it is worth while to add, are throwing no obstacles in the way; on the contrary, they, as usual, treat the whole subject broadly. The surveyors satisfy themselves that the arrangements for carrying the oil are satisfactory, and then they enter in the register book, "burning liquid fuel, experimental."

What the outcome of the experiment may be it is impossible to forecast with any pretense to accuracy. It may be that petroleum steamers as a class will find it to their advantage to burn petroleum instead of coal. It would seem, however, that the economy must be indirect rather than direct; the fuel as fuel will be more expensive than coal, but the handling of it will be much less costly. There may also be a saving in the upkeep of furnaces and boilers. It seems that the introduction of some other method of burning the oil, instead of a steam jet, would be advantageous. The loss of feed water would thus be avoided. It might be practicable to employ compressed air instead of steam, and it is scarcely probable that 110 horse power would be expended in compressing air in such a ship as the Baku Standard. It remains, indeed, to be seen whether mechanical means may not be found for accomplishing the same end. It is a curious fact that notwithstanding its high inflammability, it is very difficult to burn petroleum at once thoroughly and rapidly. Thus we find that unburned oil will drop even in the furnace of a locomotive on the coke or lime on the grate, and the unburned oil may be seen sputtering on the white-hot fire brick opposite the nozzle, and then igniting, the fine drops having had to pass through a zone of intensely heated flame before they could reach the fire tile. Up to the present it is true that nothing has been found to answer so well as the steam jet, but it does not at all follow that finality in this direction has been reached, and there is so little to be said in favor of the steam sprayer in use at sea that we may expect inventors to work hard to devise something better. Yet when all that is possible has been done the use of petroleum must remain limited, the whole weight of it available for fuel being as nothing compared to that of the coal burned each year.—*The Engineer, London.*

RABBIT SKINS.

ÆSOP, Phædrus, La Fontaine and Florian loved the rabbit for its gentleness, its innocence and its submissive philosophy. We, more practical and unfortunately less imaginative, esteem it especially for its flesh and its pelt.

The trade in rabbit skins prepared for furriery and felting is not, as generally thought, a business of small importance, a negligible quantity in our immense traffic, but, on the contrary, is one of the interesting branches of Parisian industry, giving employment to at least four thousand furriers, dressers, dyers, cutters and mounters, without counting the itinerant purchasers whose cries we continually hear in our streets.

"SECRETING," OR ACID DRESSING—THE STOVE.

The annual manufacture in the principal works in which these skins are treated exceeds two million pieces, causes the circulation of $800,000 in cash and gives livelihood to about five hundred workmen at a mean salary of ninety cents a day. Do not these figures clearly show the activity of this trade in a city in which, despite the great prosperity of the business, it is almost unknown to the public?

The leading quality of the rabbit does not reside in its flesh. This gentle quadruped, which

"*de thym parfume son banquet*,"

furnishes more than a vulgar stew. Like Horace, it does not perish entirely, and its departure from this life only serves to increase its utility.

Entirely revised and corrected by mechanics and chemistry, its fur, upon its exit from the works, possesses a luster and aspect that forthwith ennoble it. The modest inhabitant of the burrow then becomes an otter, ermine, beaver or fur seal! How many boyars and lords of the Boulevard Montmartre there are who think they are wearing a heraldic pelisse, when they are merely taking a dozen beautiful rabbit skins out for a walk!

Every one knows how the merchandise is obtained. Rich retail dealers, in a blue blouse like laborers, but whose daughters are well dowered, buy it from the itinerants. Three cents apiece is paid for it, provided it exhibits no holes, nor rents, nor scurf. Fifty skins are made into a bundle and delivered to the furrier without any other preparation than a summary beating. This centralization and transit leaves in the hands of the dealers a profit of about two cents per skin, since the selling price is from five to six cents.

The largest dealers are located in the north, in the vicinity of Paris, at Amiens, Beauvais and Reims. No trade in fine skins designed to "pass into fur" is done beyond a line that may be traced from Lyons to Rochelle. In the south, the rabbit is small, poor and short. Its hair is good for nothing except for felting.

The most esteemed skin is that of the silvery rabbit of Champagne. It may be employed directly without dyeing, as if it were derived from that graceful animal of Archangel called the Siberian squirrel. Unless one belongs to the trade, it is impossible to recognize the substitution only because it is . . . impossible! It is a singular and capricious fashion that desires defects in furs, blemishes in the diamond and typographical errors in "good editions."

The skin of the silvery rabbit is quite expensive, because it is rare as well as difficult to match. The first quality of a manufactured fur is, in fact, that of being equal in shade and marking.

As soon as the bundles reach the furrier's works they are opened and the skins counted and carefully sorted. It is important to recognize the merchandise and to classify it. The fine pieces are reserved for furs, while the others pass to the hands of the cutters of hair.

This cutting of the rabbit hair is not so simple as it appears. It requires ten operations in succession. From the time of Pliny the elder, and doubtless before the time of that observer, it has been remarked that the hairs of certain animals, such as the rabbit, beaver, camel, sheep, etc., intercross and shrivel when they

THE REPAIRERS.

are fulled mechanically. It is in this way that it has been possible to manufacture solid and durable fabrics without the necessity of weaving them. Such are the felts and the buckrams. The hair of the rabbit is undeniably the kind best adapted for this industry.

In the first place, the dry and hardened skins are soaked in water. After allowing them time to become flexible, they are placed, hair downward, upon large wooden cones in order to stretch them. These cones open in two parts, like a glove stretcher, thanks to an interior screw actuated by a small hand wheel. After the skin has yielded as much as possible without cracking, it is split by passing a sharp knife through from bottom to top on the belly side. The piece is thus opened and stretched and ready to be plucked. What are called "pluckings" are the coarse and long hairs that extend beyond the rest of the fur. The women engaged in this work earn good wages. They generally work by the piece, and often for fifteen hours at a time in an atmosphere filled with dangerous dust and hairs. So they rapidly lose their appetite and gradually travel toward the hospital. When questioned, they cheerfully answer: "Our trade nourishes!" Alas! What a nourishment is this slow continuous obstruction of the digestive and respiratory tracts! This is the reverse of progress. The pluckers make use of a sharp blade and of a leather or rubber

CUTTING MACHINE.

thumb stall to avoid cuts. They all cover their head with a *marmotte*, and take precautions for their hair that they ought really to take for their lungs and stomach. The waste (the cuttings) is sold for the benefit of the operatives. It brings a small amount of money, which is distributed throughout the entire shop.

After the skins have been divested of all the plucking, they are subjected to a dressing called "secreting;" with a bristle brush dipped in a tub containing a certain wonderful solution, the hair is thoroughly wet in such a way that it shall be rendered humid as far as to two-thirds of its length. This solution, which is now known, was of old one of the arcana of industrial alchemy. When the formula for this mixture was asked of the old furriers, they assumed the airs of Dr. Faust, and silently put their forefinger to their lips. This was all their answer. Now, the following is the secret of the "secreting" (acid dressing):

Pure, slightly tepid water	3 qts.
Nitric acid (by weight)	15 oz.
Mercury " "	2 "

This mixture has the property of preparing the hair for felting. Certain furriers claim still in our day to have a "recipe," but we can assure them that their enchanted philters would not stand for an hour before the box of reagents of the director of the Municipal Laboratory.

The skins, having been well acid-dressed, are strung by dozens upon iron rods and carried to a stove, wherein they are dried. After a few hours, the rods are taken out, the skins are aired, and the legs, tails, and useless parts—those that exceed a pattern adopted as a type—are cut off. Then the hair receives a dry brushing in order to render it loose, and the skins are carried to the shop wherein the steam cutting is to be effected. The wonderful machine that performs this fairy trick is certainly the sister of the one that in 1855 was jokingly recommended to the troops of countrymen who came to take a look at the Universal Exposition.

"This machine," it was then said, "makes a stew and a hat out of a rabbit in three minutes!" Well, the machine under consideration, in the twinkling of an eye, forms from a rabbit skin a little pile of silky down and a package of "vermicelli"! This miracle is performed upon a table upon which are installed a stationary knife and a rotary one. It suffices to introduce the extreme end of the skin in order that all

THE PRESS.

shall pass therein and be intelligently divided as we have stated.

The hair thus cut is deftly made into bundles by light-fingered women, who trim it, pluck it, and mount it in hemispherical bags. It is sold in this shape to the felters, who pay at the rate of about a dollar a pound for it.

The belly hairs, which are set apart, are not so dear, and cost about 60 cents. The pluckings are not thrown away, but are sold for carpets and for buckrams, which are imperfect felts, or are utilized for the manufacture of crews' mattresses for vessels making long voyages or for emigrant ships. As for the "vermicelli," glue is made of that. Nothing is lost in the industry, but all is transformed, because thus everything can be sold.

Now let us pass to the fur work, which has nothing in common with the preceding. Here the domestic rabbit is absolutely preferred to that of the warren, and to the hare even. Its size and the beauty of its hair are the causes of this merited favor. Moreover, as the rabbit of the warren is too often massacred by hunters, three-fourths of the skins derived from this animal are not utilizable for furs. They are "skimmers."

After the sorting and cutting off of the tails, legs, etc., the open skin is sewed up with a few rapid stitches. A sort of a purse is made of it, hair against hair, which is covered externally with the residue of colza oil. After the skins are well saturated, and the derma has become sufficiently soft, they are submitted to the action of the fulling mill, an apparatus composed of a large trough and two huge rounded hammers, which pound and repound the mass without bruising it. After a few instants of this energetic fulling, the rabbit skins become less recalcitrant, and acquire a flexibility comparable to that of the best glove. They are then given over to the "scrapers."

These workmen form the cavalry of this army of artisans. They are continually in the saddle upon a horse whose principal piece is a terrible saber in the form of a crescent. Holding the skin with both hands, they draw it, scrape it and render it thin by passing it quickly over the knife. Woe to the awkward man who makes a miss. The huge knife does not forget him who forgets it. It is true that the workmen know at once how to find a remedy for the trouble. A small piece of skin applied to the wound is the best of all diachylons.

The skins, having thus been freed from all rough or indurated parts, are mechanically scoured in large drums which, in revolving, make the sinister noise of the instrument of Ixion. These contain plaster, sawdust and three or four hundred skins. This operation is renewed twice and lasts four hours. After leaving the drum, the skins pass to the steam beater, in which they are lashed in a magistral manner amid a fearful cloud of dust. Upon making their exit, they are again smartly drubbed by a dozen young apprentices armed with rattans. Finally, they are sheared more or less closely, according to the imitation that it is desired to make of them. Sheared very short, it is the seal; less so, it is the otter; still less, it is the beaver.

Afterward come the repairers, whose art consists in repairing all the imperfections that the skin may present. It is, in fact, quite a rare thing for a piece to be without any defect. With a skill, sureness of eye and incomparable hand, the repairer removes the defective piece, selects from a pile of cuttings a similar part having the same shade and the same luster, and, in four cuts of his knife, completes the fur that he is treating. There are some skins that are mended in from five to eight places. If you have the eyes of a lynx look for them, and again put on your spectacles. It is impossible to find the juxtapositions of this mosaic work.

A careful combing terminates the work of the repairers and sets free all the hairs that have become matted. Here again comes a new classification, embracing on the one hand the skins that are to remain

in their natural color and on the other those that are to be dyed.

Before being dyed each skin is saturated several times with a special mordant whose composition is still an alleged secret. After each application of mordant the skin is dried in a stove. Finally, the skins are thrown into huge vats filled with black mixed with other ingredients, among which the copperases play the principal role. After they have remained for a whole day in this thick mixture, the skins are submitted to the action of a press quite similar to a wine one. They are then examined, and, if they are not sufficiently colored, are put back into the vats until the black saturates them. This result having been obtained, they are scoured for the last time and dried in the free air in vast latticed structures. The last classification is then made and they are arranged in dozens. The mean value of such packages is from five to six dollars. As may be seen, the Paris "otter" is much cheaper than that of Kamtschatka. In reality it is not so beautiful, but the immense difference in price is not justified by the difference in quality, and so much the more so in that the majority of the true otter, seal and sable skins, even, have likewise to undergo mordanting, secreting and dyeing in order to become salable and be delivered to consumption.

The production of the Parisian works that treat the skin of the rabbit is about twelve million pieces. Belgians also are engaged in this industry, but they proceed by tanning.

The French fur dressers have a universal and merited reputation. If London is the first market for peltry in the rough, Paris is the most important of points of re-exportation for dyed furs. The quantities employed in France reach scarcely an eighth of the total manufacture, and the port of Havre annually exports more than six million dollars' worth of peltry, hair and felt. The United States in the first place, and then Germany, Sweden, Norway and Holland, supply themselves in Paris when their furriers desire first-class goods. Our prepared and dyed peltry, particularly that of the rabbit, is esteemed not only in Europe and America, but also in Asia, and especially by the inhabitants of the Celestial Empire.

In 1860, after the taking and sacking of the State

THE SCRAPERS.

Palace, a quantity of rare objects derived from the historic pillage arrived at Paris. There was a little of everything in this immense military housemoving—vases, bronzes, furniture, arms, mandarins' clothing, and, of course, mandarins' furs. The happy possessors of those extra-oriental pelisses believed that they had laid hands upon sables beyond competition. They were appraised here, and what was not the disappointment of the assistants to learn that these undiscoverable mantles were derived from animals which had been raised from tender infancy in Paris, and *Sentaient encor le choux dont ils furent nourris.*

However this may be, our soldiers had entered Pekin, where our French furs had already preceded them.—*Le Monde Illustré.*

THE MANUFACTURE OF STRAW CELLULOSE.*

By JAMES BEVERIDGE.

THE manufacture of cellulose or paper pulp from the various kinds of straw is so well known to experienced paper makers that it is probably difficult to mention anything specially new in dealing with such a subject. This statement may also be made in regard to other fibrous plants besides straw, and it may be deemed unnecessary by some that one should occupy the time of our society on such a trite subject The manufacture as a whole is, however, unquestionably a difficult one, and there are certain problems associated with it which are of great importance to pulp and paper makers, and certainly of more than passing interest to the technical chemist.

Straw has been used for paper making from very early times. It is said that the Chinese manufactured paper from rice straw before the Christian era. This art, originating with them, gradually extended to Europe through Spain, Germany, France, Holland, and finally to England. The rapid development of the industrial resources of Europe at the beginning of this century, and our ever increasing social requirements demanding the extension of our paper industry, told heavily on the supply of rags, and gave a great impetus to the manufacture of paper pulp from fibrous plants. The scarcity of rags to meet these requirements not unnaturally caused paper makers to turn their attention to straw, because of its universal distribution and abundant supply. The invention, too, of a method of manufacturing a comparatively cheap and inexhaustible supply of alkaline soda products from common salt by Leblanc practically placed the chemical treatment of straw—as indeed all other fibrous plants—on a sound manufacturing basis. Since that period and the rise of the alkali industry in England, the inventions of Weldon and Deacon relating to the manufacture of cheap chlorine have added much to the development of the straw pulp industry. Indeed, it may be said with perfect truth that the success of this manufacture to-day fluctuates with the market value of soda and bleaching powder.

There are two kinds of pulp made from straw, viz., straw pulp proper and what may be more correctly termed straw cellulose. The former is made by steeping the straw or boiling it under pressure with milk of lime until it is thoroughly softened, after which it is washed and ground with suitable machinery and manufactured into a cheap quality of wrapping paper. This method is employed extensively in France and other countries of the Continent where there is a demand for such papers, but, so far as I am aware, is not used in England to any great extent, excepting probably in the manufacture of straw boards.

Although the subject of this paper has nothing to do with this kind of straw pulp, yet it may be mentioned incidentally that the chemical action of the milk of lime on the incrusting materials surrounding the straw fiber is not a vigorous one. These incrusting materials are not completely, nor indeed to a great extent, separated from the cellulose. The mineral matter remains in the product practically untouched, and if any less quantity than that corresponding to the percentage in the original straw operated upon exists in the prepared pulp, it is due rather to the washing after digesting than to any solvent action of the milk of lime. The milk of lime, under certain conditions, has a bleaching action on the straw. It neutralizes the organic acids usually formed when fibrous plants are heated for any length of time in presence of water. The yield of pulp obtained by such a treatment amounts to from 75 to 85 per cent. The papers produced from this pulp are of a very poor quality, and wholly used for packing purposes. They are hard, brittle, and possess a low tensile strength.

The preparation of pure cellulose from straw is a very different manufacture, and involves a cycle of operations, each one of which requires the most careful supervision. The product is used for the production of papers of first-class quality, fine and medium writings, for example, and must be well prepared, and as free from dirt as it is possible to get it. It is therefore necessary that cleanliness be observed in every department, and that the straw itself and the water used for washing, etc., be subjected to a preliminary purification, as necessity may require, before they enter the mill. It will only be necessary for me to touch lightly upon a series of operations through which the straw passes, and in order to make the whole subject plain, I will subdivide it into the following divisions:

I.—Straws. Their composition, nature, etc.
II.—Manufacturing operations.
(*a.*) Cleaning, cutting, and dusting.
(*b.*) Digesting the straw in caustic soda lye.
(*c.*) Washing, breaking, purifying, and bleaching.
III.—General data *re* (*a*) yield, (*b*) bleach, (*c*) loss of soda, etc.
IV.—Fuel and mechanical power required to produce a ton of straw cellulose.

I.—*Straws: Their Nature and Composition.*

The straws usually employed for the preparation of cellulose are those obtained from the cereals, oat, wheat, rye and barley. In some parts of the Continent maize straw has also been used, but I understand with only moderate success, as it yields a somewhat coarse fiber. Next to wood, oat, wheat, rye, and barley straws are the most universally distributed fibrous plants, known as sources of paper pulp. In point of cheapness they also rank next to wood, which is recognized as the cheapest source of cellulose at present known in this country. The physical character and composition, especially with regard to their ash contents, vary enormously. This is not only true of the different kinds of straw, but also of the same variety, and seems to depend upon the district or country in which they are grown. Probably the soil has influences on the composition of the ash as well.

The fibers contained in these straws are loosely bound together by resinous and intercellular matter, which is easily dissolved by caustic soda, and subsequently separated by washing. Thus isolated they are soft, flocculent, and admirably adapted for use in the manufacture of high class writing papers. They differ slightly from one another in their paper-making qualities; the fibers from barley straw, for example, differing from those of oat, wheat, and rye in length, breadth, and general physical character. This difference is very noticeable when the pulp from each of these straws is separately brought forward in the mill.

* From the *Journal of the Society of Chemical Industry.*

COMPOSITION OF STRAWS.

(By the method of digesting in bi-sulphite of soda.)

——	French Wheat.	Zealand Wheat.	Dutch Wheat. Ijpolden.	Dutch Oat.	Dutch Rye.	Dutch Barley.
Water	Per Cent. 11·8	Per Cent. 8·2	Per Cent. 12·5	Per Cent. 11·2	Per Cent. 7·6	Per Cent. 11·0
Ash	7·2	10·0	7·5	5·5	1·8	7·2
Cellulose (unbleached)	36·6	37·6	36·4	37·3	41·3	34·1
Organic matter other than cellulose	44·4	44·2	43·6	46·0	49·3	47·7
	100·0	100·0	100·0	100·0	100·0	100·0
Per cent. dry cellulose on dry straw	41·5	40·9	41·6	42·0	44·7	38·3
*Per cent of air dry cellulose on air dry straw	40·6	41·8	40·4	41·7	43·9	37·9
Per cent. silica (SiO_2) in straw	4·40	6·24	5·17	2·35	0·02	2·66
Cwts. straw to produce 1 ton of air dry cellulose	4·9	4·8	4·5	4·9	4·5	5·7
Cwts. of silica from 1 ton of air dry cellulose	2·15	2·98	2·56	1·12	0·40	1·65
Cwts. of 60 per cent. alkali (Na_2O) required to form Na_2SiO_3 with the total silica.	3·70	5·11	4·39	1·93	1·02	1·85

* Air dry cellulose containing 10 per cent. of moisture. Air dry straw containing moisture as shown above.

It is not very difficult to classify the straws according to the nature of the fiber or cellulose they yield, although such a classification as I am about to attempt is true only locally. My experience being confined to Dutch straws, the following bears directly on them:

Barley straw yields a short, very soft fiber of low felting power. The knots and husks are soft, and in consequence this kind of straw is easily digested.

Oat straw is usually somewhat harder; the knots and husks are more difficult to digest. The fibers it yields are comparatively long, soft, and of medium felting power.

Wheat and rye straw are, according to my experience, closely allied. They both yield long fibers of good felting power, and are the most valuable as sources of cellulose. Rye straw in particular yields cellulose of excellent quality, and as it usually contains a comparatively small quantity of mineral matter, it is soft and easily digested.

The classification of these particular straws grown in other countries would doubtless be different, because the amount of ash they contain controls to a large extent the facility with which they are converted into cellulose.

The composition of these straws, according to Muller, an oft-quoted authority, also varies enormously. His analyses, which I reproduce, plainly show this:

COMPOSITION OF STRAWS (MULLER)

	Winter Rye.	Winter Wheat.	Summer Barley	Winter Barley.	Oats.
Water	Per Cent 14·3	Per Cent 14·3	Per Cent. 14·3	Per Cent 14·3	Per Cent. 14·3
Organic constituents	82·5	80·2	79·7	80·2	80·7
Ash	3·2	5·5	...	5·5	5·0
Fat and wax	1·3	1·5	1·4	1·4	2·0
Nitrogenous bodies	1·5	2·0	3·0	2·0	2·5
Starch, gum, &c.	25·7	28·7	31·3	28·4	30·2
Cellulose	54·0	48·0	43·0	48·4	40·0
Per cent. of dry cellulose on dry straw	63·0	56·0	50·1	56·4	46·6
*Per cent. air dry cellulose on air dry straw	69·0	53·3	47·7	53·7	44·4

* Air dry cellulose containing 10 per cent. of moisture. Air dry straw containing 14·3 per cent. of moisture.

The estimation of the cellulose in fibrous plants by the method recommended by Muller is a long, tedious process, and is difficult to perform with accuracy in the laboratory. In my opinion it is uncertain, and requires experience and the exercise of great care in order to obtain concordant results. Few paper or pulp makers will believe that the percentage of cellulose obtained by him in some of the above examples really represents the truth. Some of them, according to my experience and researches, are unquestionably high, and cannot be taken as representative of the class of straw to which they relate. Although it is impossible to assign a definite percentage of cellulose to any one class of straw, yet practical manufacturing yields are fairly constant, and it is very probable that Muller has included other organic matters closely allied to cellulose in the percentages given under this heading in his table.

It is manifest that a process is required for quickly estimating the cellulose available for paper making in fibrous plants, especially one that will be fairly accurate and yield results more surely indicating the yield it is possible to get in manufacturing practice. It is well known that weak aqueous solutions of bisulphites of soda, lime, or magnesia, at moderately high temperatures, do not dissolve cellulose so readily as solutions of caustic soda, if indeed they can be said to dissolve cellulose at all. The method of estimating the cellulose in this way seemed to me to yield much more satisfactory results than Muller's method, and I have used it for many years for ascertaining the amount of cellulose in a great variety of fibrous plants and other kinds of paper stock. By digesting a known weight of the plant, etc., in an aqueous solution of bisulphite of soda, lime or magnesia, and after washing, bleaching, and drying, making an allowance for the mineral matter in the pulp, the percentage of cellulose may be readily calculated. This method yields results invariably much lower than Muller's figures, and very closely resembling manufacturing yields, and therefore I believe more truly represents the cellulose available for paper-making purposes. Some of the results obtained by this method are the following, viz.:

It will be noticed in both of these tables of analyses that the percentage of oven dry cellulose in the oven dry straw has been calculated in each case for comparison, and that the descending order in which the straws indicated yield in my own table is as follows, viz.: Rye, oat, wheat (average), and finally barley. On the other hand, the order, according to Muller's table, is different: rye, wheat, barley, and oat. If the results from both tables be compared, the difference between the percentages given for each class of straw is so great that, as I have previously stated, the experienced pulp or paper maker would decline to accept Muller's results as representing the truth. Of course, I am well aware that this depends entirely on what one calls "cellulose." If the organic intercellular matter, insoluble in ether, benzol, and ammoniacal water, which binds the individual fibers together in the plant can be considered as cellulose, then Muller's figures are no doubt correct. On the other hand, this intercellular organic matter appears to offer little resistance to the solvent action of weak caustic alkalies and bisulphites, and certainly from a paper maker's point of view, cannot be considered as available for his use.

II.—*Manufacturing Operations.*

(*A.*) *Cleaning.*—The straw as it is brought from the stacks or store house is first of all passed through a machine to thoroughly open it; or this may be done by hand. It is then delivered or placed upon tables made of wire gauze, ¼ in. meshes, alongside of which girls stand whose duty it is to remove all weeds and other plants likely to produce what is known as shieve, in the finished pulp. From these tables it is elevated either automatically or by hand to the cutter, which usually consists of an ordinary chaff cutter used by farmers. The straw is fed continuously by an endless traveling belt through an orifice across the face of which, at right angles to the feed, a wheel revolves, having one or more knives attached to its spokes. The length of cut varies from ½ in. to 1½ in. From this the chaff falls on to an inclined jogging sieve of ⅛ in. wire gauze, and in traveling to the lower end the bulk of the sand, husks, and fruit grains are separated. Although the chaff at this stage is tolerably well cleaned, some manufacturers prefer to give it a final dusting, and to do this they employ a revolving sieve, through the center of which a shaft revolves at a high velocity. This shaft has pegs studded along its length at equal intervals, and so placed as to form a kind of archime-

dean screw. The sieve is cone-shaped or slightly inclined, and as the chaff travels forward, all loose dust is separated, being carried through the meshes by the current of air induced by the revolving shaft. It is then stored in heaps ready for the pulp boilers.

The object in subjecting the straw to such a trenchant system of cleaning as above indicated is to remove all foreign weeds, husks, fruit grains, and sand. This is absolutely necessary for the production of high class pulp, for it has been found by experience that these impurities produce more or less unbleachable particles, and much of the success attained in avoiding these imperfections depends on the completeness and care with which the straw is primarily cleaned before it enters the pulp boilers. The loss incurred by cleaning will depend upon the quality of the straw, but it should not exceed 5 per cent. of the total weight operated on.

(*B.*) *Digesting the Straw in Caustic Soda Lye.*—The boilers usually employed for doing this are of the rotary type, either cylindrical or spherical. Very seldom are upright stationary boilers used. The reason of this seems to lie in the necessity of keeping the mass within the boiler in a continual state of motion, so that each particle of straw will be equally acted upon by the caustic lye. This cannot very well be attained in stationary boilers, even with the usual vomiting arrangement, because the chaff, when softened by the lye, sinks down into such a dense solid mass as to interfere with the free circulation of the lye through it.

Of the two rotary boilers mentioned, the spherical type offers certain advantages over the other. It occupies relatively less floor space, is more easily filled and emptied, and presents less radiating surface per unit of capacity. These boilers are usually provided with two man holes, a blow-off cock, etc., and are heated by steam injected through the trunnion. Motion is given to them by means of worm gearing fixed to the standards supporting the boiler.

The strength and volume of the caustic lye employed necessarily vary in different mills, according to the kind of straw used and upon other conditions peculiar to the nature of the apparatus in use, *e. g.*, the steam arrangements of the factory. Both are slightly modified when barley straw is used alone, but as in actual practice the best results are obtained by mixing the different kinds of straw and keeping the mixture as nearly as possible constant, any rule laid down with respect to the proportion of caustic lye required is adhered to from day to day. The actual quantity of caustic soda, reckoned as 60 per cent. alkali, also varies slightly with different kinds of straw, as well as on the temperature and speed with which the digesting operation is carried out. Where the temperature is high and the time given for the boiling is long, the caustic is reduced to a minimum.

The following figures, representing the "charge," etc., of a straw pulp boiler, are from actual practice:

Weight of straw (mixture of oat and wheat)....	4,480 lb. (40 cwts.)
Gallons of caustic lye.....	1,610
Hours under steam pressure.....	4
Steam pressure above atmosphere.....	60 per sq. in.
Maximum temperature.....	307° Fah.

CAUSTIC LYE.

Twaddell.....	10½°
Total weight in pounds.....	16,945
Percentage by volume of Na_2O	0·3249
" " 60 per cent. alkali...	0·5416
Total 60 per cent. caustic soda in pound	872

Pounds of 60 per cent. caustic alkali on 1 cwt. of straw = 21·8.

The operation of digestion is very simple. The pulp boiler is filled as full as possible with the cut and cleaned chaff and the required volume of caustic lye run in. The manlid door is then put on and a small quantity of steam admitted, while the boiler is made to revolve for 15 minutes or so in order to soften the straw and cause it to subside to make room for more. When this is done the lid is again removed and the vacant space within the boiler filled up with more straw. In this way the charge of straw per boiler is increased from 15 to 20 per cent. When the boiler is thus filled and the manlid fastened on, high pressure steam is injected into the charge through the trunnion, and the pressure gradually raised to the desired degree. The pressure varies in different mills, but as a rule it registers from 60 to 90 lb. per square inch. This pressure is reached after about two hours' steaming, and is further maintained for 4 or 4½ hours. In the meantime the boiler is kept continually revolving.

(*C.*) *Washing, Breaking, Purifying, and Bleaching the Straw.*—After the digesting operation has been completed, the whole contents of the boiler are emptied into a tank placed beneath it, where the crude cellulose is washed with hot water. It is necessary to accomplish this work with the least possible quantity of water, in order to avoid undue dilution of the waste lye. The most efficient method is that of the application of the principle of displacement as carried out in the lixiviating of ball soda in the Leblanc soda process. It is possible in manufacturing practice to remove 95 per cent. of the soda associated with the boiled straw cellulose by this system of washing with a dilution of about one-third, that is to say, that pulp can be washed in the tanks with a quantity of water represented by one-third of the volume of black lye associated with the pulp. The weakest washings from these vats are run to waste, as it does not pay to evaporate them, even although the most refined system of evaporation be used for their concentration.

After the bulk of the black soda lye has been removed in the way described, the crude cellulose is allowed to drain, and then conveyed to an apparatus called a "breaking engine," in which it is broken into pulp.

In this engine it is again washed to remove the last traces of soda; and a proportion of the intercellular matter surrounding the fibers, as well as any dirt, will pass away with the wash water. That part of the intercellular matter carried away is in a fine state of division, and if it be left in the pulp, it is supposed to consume a large quantity of bleaching powder in the subsequent bleaching. As a matter of fact, however, if the straw be properly boiled in the first instance, the intercellular matter has little influence on the amount of bleach required to bleach unit weight of crude product. It is possible to wash straw pulp in the breaking engine to such an extent as to seriously affect the yield of pulp, and therefore the bulk of the washing can be most advantageously done in the tanks.

The pulp, although now broken up, so that the fibers are separated from one another, is not yet in a fit state of purity to be bleached. It invariably contains a few unboiled pieces of straw, or possibly some unboiled knots or hard weeds, and it is absolutely necessary to separate these to get a clean product. In order, therefore, to cleanse it, the contents of the breaking engine are emptied into a large tank, and pumped into special purifying apparatus. This apparatus consists of a long shoot, called a sand trap, as a rule about 200 feet or more in length, about 18 in. wide and 9 in. deep, containing, at intervals of 18 in. or so, cross boards about 4 in. high, and inclined toward the flow of the pulp. At the end of this sand trap, a series of cast iron boxes, called strainers, are placed. These strainers contain brass plates, having very fine slits cut in them, and it is through these slits that the individual fibers pass, while the rough, hard, unboiled pieces are retained. After the pulp passes through these slits, it is practically pure and clean. The width of slit of course regulates to a certain extent the degree of purification required.

The pulp before entering this apparatus is largely diluted with water to enable the particles of sand, dirt, and heavy weeds to subside as the mixture flows over the submerged cross boards. Any impurities which pass the sand trap are retained by the strainer plates.

It is now necessary to remove the large excess of water from the cellulose before bleaching, and this is done in a variety of ways, one of the best being by means of a machine called a "tambour." This is simply a skeleton cone made of hard wood and covered inside with fine brass wire gauze. The whole is mounted on a horizontal shaft running through its center, and as the pulp flows into the narrow end, as it revolves, the water passes through the wire gauze, while the pulp is discharged from the wide end, in a concentrated state, into a reservoir, from whence it is pumped into the "potcher."

The "potcher" is constructed on the same principle as the "breaking engines," but as the name implies, is used simply as a mixing machine. When full, a certain volume of a clear solution of bleaching powder is added, and the stirring continued for an hour or two, when the whole charge is run off into large concrete tanks, fitted with false bottoms of perforated tiles. In these tanks the mixture of pulp and bleach liquor is allowed to remain for 12 or 16 hours, by which time the hypochlorite will be exhausted, and the pulp of a white color.

It is only necessary to allow the spent bleach liquor to drain away, by drawing a plug from its seating in the bottom of the tank, and then removing the cellulose to another tank, where it is mixed with clean water, and finally pumped on to the paper machine, by which it is converted into a thick sheet of paper, in which state it is sold.

The foregoing in effect embraces the routine of this manufacture. The apparatus, both in arrangement and detail, is modified in different mills. The operations are simple, and require no great skill to carry them on successfully, but the chemical problems involved in the economical production of straw cellulose are more difficult to deal with, and I now propose to touch upon the most important of them.

(*To be continued.*)

SELF-ACTING SPRAYING DEVICE.

AT Messrs. C. & S. Frank's office, 25 Aldermanbury, E. C., London, a simple but ingenious contrivance may be seen, which will be found of considerable use to pharmacists, so says *The Chemist and Druggist.* Mr. Frank describes his invention as a "water-pressure accumulator," and our illustration shows it at work.

The accumulator is a metal globe, with an aperture at the top by which it is filled. If held under a tap, and closed rapidly when filled, it retains not only the water, but the greater part of the air with which the fluid is mixed, according to the amount of pressure behind it. A mouthpiece is then screwed to the bowl

(these mouthpieces are obtainable in various sizes and shapes), and the tap turned on, when a spray or jet, varying in height and intensity, will be produced, which in a gallon apparatus will last for about half an hour. The spray is produced by the air in the bowl, which the inflowing water compresses at the top, expanding as soon as the tap is turned on, and expelling the water. To effect this purpose a tube has been fitted inside the bowl, leading from its upper part to within a short space of the bottom, which is the only exit of the compressed air.

The bottom part of the bowl can be unscrewed to remove the residual water and to introduce scent or other substances which it is desired to distribute. To chemists the "accumulator" should be particularly useful for perfuming ballrooms and other apartments, and as a disinfector. By using mouthpieces of various kinds, the apparatus may be made to do service as a toilet douche, an ear or throat spray, a fountain, etc.

Our second illustration shows the manner of filling the accumulator at the tap. A rubber-topped ring is screwed lightly to the neck of the globe, and connected with the tap. When the sound of the inflowing

water ceases, the globe tap first and then the water tap should be closed, and the accumulator disconnected.

COAL TAR PITCH: ITS USES AND FUTURE MARKET.*

By R. WATT.

COAL tar pitch twenty-five years ago was comparatively a new factor in the commercial world. It was almost unknown. Whenever pitch was mentioned, the mind of the merchant or manufacturer reverted to the pine tar product of North and South Carolina. Even the gas companies of the United States were ignorant of the commercial value of tar. Instead of turning it into a source of revenue, their main object was to dispose of it in a way that should not pollute the rivers or streams near their works, and cause a public nuisance. Consequently they wasted millions of gallons of tar, which, if turned into pitch and the avenues of uses had been opened to it, would have largely augmented their revenues. As a result of this lack of foresight, consumers not being educated in its uses, they were limited to the use of pine tar pitch and resin for roofing, and other purposes.

When pitch was placed on the free list, foreign pitch was reduced in price and came into general use in this country, largely owing to its cheapness; but it was often of such poor quality that it was unavailable for many of the functions of pitch. The cause of this poorness was obvious. Foreign producers, who were also little instructed in the advantages of pitch in its various lines, did not regard their product of much importance, and thought that anything would suit so long as it was called pitch. They distilled the tar mainly for the resultant oils and chemicals, and pitch with them was only a by-product of many impurities. It was usually hard and brittle, and contained many foreign substances which were detrimental to its utility. Its importation, however, brought pitch into more general use by reducing the price of what pitch was manufactured in this country.

Now, while this result curtailed the revenues of the gas companies engaged in the production of coal tar, it also stimulated them into better appreciation of the commercial worth of the product. The tar distillers revised their methods of manufacture, and sought to meet the necessities of the growing market. Instead of treating pitch as a by-product, as many of their European competitors still do, they now distilled the tar solely for the pitch; and looked upon the resultant oils and chemicals as the by-products of secondary interest from a commercial point of view. Owing to this change of front on the part of the distillers, the coal tar pitch of the United States takes first rank in the market. It is free from the impurities of the imported article, and therefore better adapted for the various purposes for which coal tar pitch is now used.

In this brief paper I need only call attention to a few of the leading uses of coal tar pitch. For roofing purposes it is unsurpassed, and is in general vogue in all our large cities. Its superiority over tin and iron roofs is everywhere admitted.

During the past fifteen years it has become the principal factor in nearly all the prepared roofing on the market. A combination of pitch and felt resists the action of water much longer and is more durable than any other class of roofing material; and, what is of equal importance, the cost of such roofing is one-third less than roofs of tin or iron. It, moreover, makes a much safer roof in the case of fire. While the metal roofs disjoint and fall to pieces from the action of heat, and thereby add to the intensity of the fire, pitch roofs fall down bodily and tend to smother out the flames, and in this respect effect a much quicker result than thousands of gallons of water.

In street paving the advantages of pitch have frequently been demonstrated. In many cities specifications call for from 10 to 20 per cent. of refined Trinidad asphalt, added to the pitch or cement employed in paving; but this clause is rarely complied with. Practical men know that the addition of this asphalt is more of a detriment than a benefit to the pavement, and they condemn and reject it, even when set forth in the specifications. City authorities, as well as contractors, know that block stone pavements are not satisfactory or durable; unless pitch has been used for filling the crevices or cementing the blocks together. Years of costly experiments were needed, in many instances, to substantiate this fact; but to-day pitch filling is regarded of the utmost importance; since pavements so treated are more lasting and less subject to ravages of water than those which have been laid without pitch as cement and filler. Indeed, pitch pavements are practically impervious to water, and accordingly escape its corrosive or undermining effects.

In Eastern, Central, or Southern cities, where brick

* Read at the tenth annual meeting of the Ohio Gas Light Association, at Columbus, O., March 21 and 22, 1894.

pavements have largely superseded all other styles, it has been proved that without a pitch filling, such pavements are like leafy roofs in wet weather. The rain percolates through the crevices and injures the foundation, rendering repairs necessary in a very short time. Pitch, on the other hand, prevents the bricks from absorbing moisture, effectually seals up the joints, and keeps the pavement firm and intact. Should the pavement sink from any cause, the points of fracture join naturally together again; whereas, with hydraulic cement or mineral grout of any kind, breaks and cracks are hard to repair, and pavements so laid soon present a ragged and uneven surface.

Coal tar pitch was extensively used for the vulcanite asphalt pavements in Washington, D. C., which was admitted to be the finest in the country. A recent estimate shows that 1,500,000 yards of asphalt and 500,000 yards of vulcanite have been laid in that city with pitch or coal tar distillate; and in all instances where the proper ingredients or proportions have been used, the results have been in the highest degree satisfactory. Pitch is also used to excellent purpose in floorings of establishments where there is much moisture. Where oils or acids are liable to fall, an asphalt floor laid with pitch is superior to asphaltum alone. Petroleum softens asphalt, but it has no effect whatever on a floor of coal tar pitch. These facts have been recognized in numerous cities. In Pittsburg fully 80 per cent. of the asphalt pavements have been laid with pitch, with splendid results.

But there are other and equally important avenues for the employment of coal tar pitch. It enters extensively into the manufacture of carbons for electric lighting. Various substitutes for pitch have been tried, but none have thus far proved successful. In Germany it is used in the manufacture of pipes for the conveyance of cold acids in chemical works, and also for lining acid holders. Underground pipes for gas or water are coated with pitch to prevent rust or corrosion. Boat bottoms are pitched to preserve the timber and give a smooth surface. The wooden pipes, manufactured in Michigan and New York, are made more useful and durable by their pitch coating.

Another important use for coal tar pitch has been found in the manufacture of egglette coal, the new fuel which bids fair to revolutionize the market. This fuel is made of hard and soft coal dust, mixed with 10 per cent. of pitch, and pressed into egg-shaped pieces. Its popularity for family and manufacturing purposes is already so pronounced that factories for its production are contemplated in various sections. This industry will undoubtedly give great impetus to the pitch market. Even the dust and screenings of the mines can be converted into as valuable a fuel as hard coal, while many grades of Western coal can be rendered bituminous by the use of pitch as a binder. All the indications are that the demand for the new fuel will go on increasing. In England its manufacture and sale has already reached large proportions, and egglette has given great satisfaction whenever tried.

Owing to the manufacture of gas from petroleum products, of late years the supply of coal tar has diminished. A quantity of pitch obtained from gas tar derived from petroleum products has been used for paving and roofing purposes; but the large percentage of water in the tar has rendered it very difficult to handle. While the pitch made from this tar is not as good as genuine coal tar pitch, yet the cheapness of the tar has forced it into the market as a substitute for many purposes, with fair success.

The expanding market, as well as the revenue from the production of pitch, ought to stimulate the production of coal tar, and tend to the diminution of gas making from petroleum. When the gas companies fully realize the conditions of the market, they will no doubt govern themselves to meet those conditions in the most profitable manner. Besides those already referred to, there are hundreds of avenues, some of them individually small, but large in the aggregate, for the consumption of pitch. Indeed, taken altogether, the outlook for this valuable product of coal tar is very promising. With the increasing demand for felt roofing, the growing popularity of brick for paving, where pitch will in time be universally used for filling, the employment of granite block for paving with pitch filling, the extension of electric light, causing a larger demand for carbons, and the expanding consumption of the new fuel, to say nothing of the many minor avenues of use, the producers of coal tar pitch certainly have every reason to expect a bright and profitable market.

THERMOSTATIC REGULATORS FOR INCUBATORS AND OTHER HEAT APPLIANCES.

By G. D. Hiscox, M.E.

In answer to the many inquiries in regard to the construction of thermostatic bars, heat regulators and ventilators for incubators and other purposes, we illustrate such as we have tested for reliability, and of a construction within the means of most amateurs.

The materials that possess a large range of motion for each degree of change in temperature are somewhat limited, and, with the best, its range requires to be multiplied for effective work.

Among the metals, zinc has the largest range, equal to 0·0002 of an inch per foot in length for each degree F. of change of temperature. This being too small for the direct movement of a zinc rod, even when multiplied by a lever system, in order to utilize it to the best advantage the zinc rod may be fastened to a strip of thin steel which has a movement of only 0·00007 of an inch per foot in length for each degree of change in temperature, and thus multiply its range by differential expansion and lateral motion as shown at A, Fig. 1. The strip of zinc may be cut from rolled sheet zinc No. 16, not less than 2 feet in length clear of fastenings, 2 inches wide at the butt end, tapering to ½ inch at the free end. The strip of steel No. 30, or if steel cannot be easily procured, a strip of Russia sheet iron will be nearly equal, having a slightly higher expansive property, may be cut of the same form as the zinc, but slightly longer for making the damper connection as shown in the cut. The strips should be riveted together with soft copper wire 1-16 of an inch diameter, headed lightly and only sufficiently to hold the strips together. The lever and bell crank connections with the damper should be made very light and with an adjusting screw and nuts as shown.

The lateral motion that should be obtained in a clear length of 2 feet, for the free end, is ½ of an inch for each degree or ¾ of an inch for the full range of 6 degrees for an incubator.

Another combination as shown at B, Fig. 1, may be made with a strip of hard rubber which has a range five times greater than zinc, or equal to 0·001 of an inch per foot in length for each degree of change of temperature. It will not have a proportionally large range, because it must be made of thicker material in order to give the bar the proper stiffness of motion. A combination of a hard rubber strip ¼ inch thick, 1 inch wide, or if convenient wider at the butt, as in the first named arrangement, with a piece of sheet steel, Russia iron No. 20, or a strip of heart hickory ½ in. thick, will give a strong motion and a range of nearly ¼ inch for each degree of change of temperature in a bar 2½ feet long clear of fastenings.

The volute coiled thermostat, Fig. 2, is a very compact form, although a little more difficult to make.

The strips of steel or iron and zinc are to be made as in Fig. 1, and may be 2½ feet long Instead of riveting the strips together, they should be cleaned on the faces that are to be united and tinned with pure tin by a soldering copper; then placed together, bound with strips of wood and the edges united by melting the tin with a hot soldering copper. Any tinsmith can make a neat piece of work in this line. It can then be bent in the form as shown, and the butt end screwed to a wooden stud, or soldered to a metal bracket.

The manner of connecting the spring with the lamp and warm air flue is plainly shown in the cut, subject to any modification required by the position of the lamp and the thermostatic coil. The connecting rods, C and D, have a running thread and two nuts on each for adjustment of the air valve and lamp flame; the latter being operated by a sleeve sliding loosely over the wick tube and operated by a bell crank shaft so as to cover the wick without moving it in the wick tube. The lamp chimney, B, should be made of thin copper for the best transmission of heat, and the warm air chamber, A, may be made of tin. The counterbalance weight, E, may not be needed if care is taken to otherwise balance all the moving parts.

The round rod of hard rubber is also in use for thermostats, as shown in Fig. 3. Such a rod should be 5/16 inch in diameter by 3 feet in length, and will have a temperature variation of 1-40 of an inch for 6 degrees, by multiplying which by a delicately arranged bell crank with adjusting screws as shown in Fig. 3, the warm air throttle and burner sleeve will receive the proper amount of motion for regulating the temperature of an incubator.

The rods and strips of hard rubber are kept in stock by the makers of hard rubber goods, and may be obtained through the rubber trade.

Other constructions of thermostatic regulators are in vogue, such as a long brass wire, about No. 30 wire gauge, wound around a series of small grooved wheels set some distance apart on a wooden frame, but as brass wire only varies 0·0125 of an inch per 100 feet for each degree change of temperature, or 0·075 of an inch for 6 degrees, it is not suitable for the purposes of an incubator. A flat hollow disk of hard brass with concentric corrugations, half filled with sulphuric ether and hermetically sealed with solder, has a large range of movement. The ether boiling at from 98° to 105° Fah., according to its purity, and thus generating a slight pressure above its normal vapor pressure near its boiling point has also been used. It is of too inflammable a nature to be recommended for amateur use.

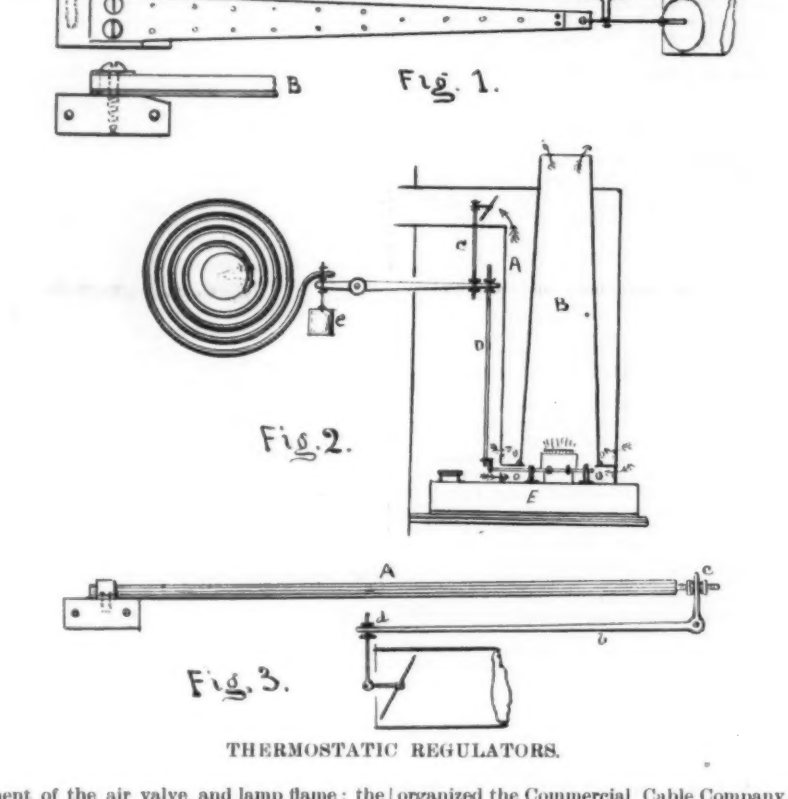


Fig. 1.

Fig. 2.

Fig. 3.

THERMOSTATIC REGULATORS.

A NEW TRANSATLANTIC CABLE.

On August 16, 1858, at twelve minutes past eleven in the morning, telegraphic communication between the Old and the New Worlds was inaugurated by the following dispatch sent fron Valentia to Newfoundland:

"Directors Atlantic Telegraph Company, Great Britain, to directors in America. Europe and America are united by telegraph. Glory to God in the highest; on earth peace, good will toward men." On September 1 following, however, the cable ceased to work, having, during the twenty-three days, conveyed 400 telegrams of 4,359 words and 21,421 letters. It was not until July 28, 1866, that telegraphic communication was again restored between the two continents by a new cable, and from that date the Anglo-American Company had no rival until August 15, 1869, when the French Atlantic Company's cable began operations. The competition thus commenced brought the tariff of both companies down from £1 a word to £1 10s. for ten words. Further competition was avoided by combination. Somewhat similar arrangements followed later attempts at competition. Thus, in 1874, the Direct United States Company entered the field, brought down the rates, and finally, in 1877, was forced into combination. In 1879 the French "Pouyer Quertier" cable was laid, and in the following year entered into a joint purse arrangement. Then, in 1881 and 1882, the two Western Union (Gould) cables were laid, and in the following year also joined the combination.

The next competition which the old company had to face was of a different character to the former attempts, the capital for the new cable being practically supplied by Mr. Mackay, the "Bonanza King" of California, and Mr. Bennett, the well-known proprietor of the *New York Herald*. These enterprising gentlemen in 1883 organized the Commercial Cable Company, and have since maintained the independence of their undertaking. The competitors have wisely given up a "war of rates," and content themselves with energetic and determined attempts to secure a fair share of that transatlantic cable business which has so far kept the companies' lines fully employed. The competition for business thus insured, together with the natural development of international relations, has, indeed, caused such an increase in the daily telegraphic correspondence between this country and America that the Anglo-American and Commercial companies have found it necessary to lay new cables. The Commercial Company in this race are slightly ahead of their rivals, and their steamer with the two shore ends started recently. Since the last cable was laid in 1884 experience and scientific research have indicated directions in which the old cables might be improved, and the new lines of the Commercial and Anglo-American companies, it is safe to say, will be far ahead of the old ones in carrying capacity, durability, and in other respects.

Messrs. Siemens Brothers & Co., Limited, laid the two cables of the Commercial Company, and naturally, therefore, secured the contract for the new Mackay-Bennett line. The headquarters of Messrs. Siemens are in one of the fine old mansions at Queen Anne's Gate, Westminster, and our representative, who called for particulars concerning this new link of communication with our transatlantic cousins, found Mr. Alexander Siemens in one of those delightful rooms overlooking St. James's Park which make the rush and hurry of these latter days appear strangely out of place, and unsatisfying.

A visit to the company's great works at Woolwich, with their electrical appliances, steam hammers, and all the other adjuncts of a mighty workshop, brings one back, however, from the old world memories of

Queen Anne's Gate to the hard realities of to-day. A submarine cable consists first of a core, which comprises the conductor, made of a strand of copper wires, and the insulating covering, generally made of gutta percha, but occasionally of India rubber, to prevent the escape of electricity. Then comes a layer of tanned jute yarn laid over the gutta percha to protect it from the sheathing of steel wires, over which come again jute yarn and a bituminous compound. The sheathing varies in type, Mr. Siemens explained, with the depth of water in which the cable is to be laid. This sheathing may consist of as many as seven types, increasing in strength and protective power as the shallow water is approached. The core is the same throughout.

HOW THE CABLE IS MADE.

The copper wires for the conductor are twisted up together or stranded; they are then passed through the covering machine, by which the gutta percha is squeezed round the conductor in a continuous envelope touching it throughout. The core is then served with jute yarns, which are laid spirally round it, forming an elastic soft bedding for the sheathing wires. These latter, as well as the outer serving and compound, are put on in one machine. The served core passes through the hollow shaft of a circular skeleton framework of iron, on which are mounted bobbins filled with steel wire or jute yarn, as the case may be. This framework can be rotated, and the cable being at the same time drawn along, the wires or yarns are wound spirally round the core. The bituminous compound is applied by the cable being passed under a spout from which the melted compound runs. The finished cable is then coiled in large circular iron tanks, in which it is kept under water.

HOW THE CABLE IS LAID.

The cable ship is fitted with similar tanks in the hold, and the cable is coiled away in them, being drawn out of the land tanks. When the ship is at sea, the cable runs out over a large pulley at the stern of the ship, having to pass on its way from the tank over and under several retarding wheels, then round a large brake-wheel, by means of which the speed at which it runs out can be regulated; and then under a dynamometer, the object of which is to indicate the amount of strain to which the cable is subjected at any moment, and also to enable the man in charge of the brake-wheel to regulate the amount of strain put on by the brake to suit the varying conditions of laying. When all the available cable has been laid, the end is carefully sealed up, and having been attached to a rope, is lowered to the bed of the ocean; a buoy is attached to the other end of the rope, and is left floating on the surface of the water to mark the position of the end of the cable. During the whole time that the cable is being manufactured and laid electrical tests are continuously taken, so as to make sure that everything is in order.

There are at present ten Atlantic cables, and two more will, as above stated, be laid this year. Of these twelve cables, seven will have been made and laid by Messrs. Siemens Brothers & Co.

In 1875 Messrs. Siemens Brothers & Co. laid the direct United States cable, in 1879 the French cable, in 1881 the northern Western Union Cable, in 1882 the southern Western Union cable, and in 1884 two cables for the Commercial Cable Company. This company having decided to lay a third cable, the order for it was placed with Messrs. Siemens Brothers & Co. on November 21 last, and the manufacture was at once started at their works at Woolwich, so as to have it completed in good time for laying during the favorable season. The rate of manufacture has been unusually rapid, being, for the deep sea type, more than five nautical miles (a nautical mile = 2,029 yards) per machine in twenty-four hours (the manufacture is carried on continuously day and night); and there being ten cable machines at the factory, from 50 to 55 nautical miles of deep sea cable can be turned out in every twenty-four hours. The new commercial cable will have a much greater weight of conductor and of gutta percha than any of those previously laid, and in consequence the speed of signaling through the new cable will, Mr. Siemens maintains, be at least one-third faster than the speed on either of the former cables made by his firm for the Commercial Cable Company. A few years ago such a fast cable would not have been worked up to its full message carrying capacity, because the ordinary telegraph operator could not have manipulated his apparatus fast enough by hand. But the Commercial Company now employ automatic sending apparatus which enables them to attain a high speed, while insuring accuracy. The following are the weights of material used in the manufacture of this third commercial cable, which is in all 2,201 nautical miles in length: Copper wire, 495 tons; gutta percha, 315 tons; jute yarn, 575 tons; steel wire, 3,000 tons; compound and tar, 1,075 tons; total, 5,460 tons.

The laying of the cable will be done by the telegraph ship Faraday, belonging to Siemens Brothers & Co., and specially designed by the late Sir William Siemens for cable work. The cable is stored on board in three large tanks, two of them being 45 ft. in diameter and 30 ft. deep. The three tanks together are capable of holding 1,700 miles of cable. The laying will be done in two expeditions: the first has just started, and will comprise the shore ends and intermediate sections—in all about 700 nautical miles. The first section will be laid from Waterville, in Ireland, out into deep water, and the end will then be buoyed. The second section will be laid from Canso, in Nova Scotia, over the Great Bank of Newfoundland into deep water, and this end will then be similarly buoyed. The Faraday will return to Woolwich to take in the cable for the second expedition, which will start in the middle of June, and will comprise the 1,500 nautical miles of deep sea cable. The laying will begin from the buoyed end of the cable laid out from Ireland, and continue across toward America till the buoyed Nova Scotia end is reached, when the final splice will be made, and the cable will be completed throughout. Under favorable circumstances of weather the laying can proceed at the rate of about seven nautical miles an hour, so that the laying of the deep sea section should be completed in about ten days.—*London Daily Graphic.*

AN ADJUSTABLE MICROPHONE.

By W. H. SOULBY.

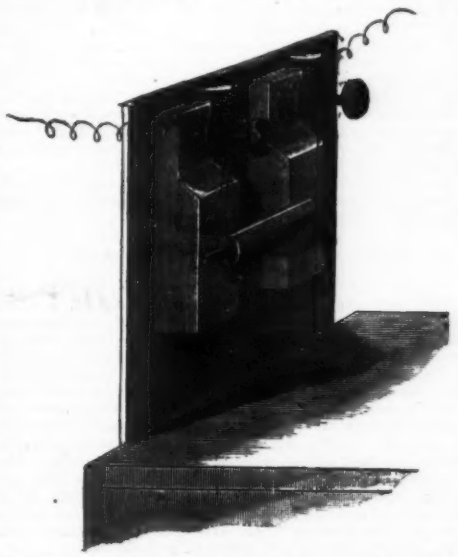
THOUGH no claim is made to novelty in the following apparatus, yet as it appears to possess certain features which have not hitherto been published, and as experience has proved that the facilities for delicate adjustment are very marked, I have been induced to describe the same.

First, as to the arrangement of the carbons, which are fixed to a small sheet of ebonite about 5 in. × 3 in., which again is fixed to the end of a sounding box (a cigar box does duty in the present case). Two blocks of carbon, each 1½ in. long by ¼ in. thick, are cut down at one end to form a lip or flange, through which the binding screws pass to fasten the carbons to the ebonite sheet. The vertical screws connect the wires conveying the current. The horizontal screws have each a short length of sewing cotton wrapped around them; a piece about 8 in. long is doubled, the two ends being brought together, are placed on the screw, and wrapped round it, leaving a loop of about one inch long hanging down, at the end of which a noose or slip knot is formed to carry the reduced ends of a small cylinder or pencil of carbon, about 1 in. long, which remains suspended thereby, and can be raised or lowered by a turn of the screws.

This suspended cylinder of carbon just hangs clear of the fixed carbon blocks. The connecting wires are brought into contact, but no current passes until the carbons are made to touch each other. The sounding box is then slowly tilted up (by means of a wedge pushed gradually under the end of it) till the carbon cylinder rests against the fixed blocks, just lightly enough to obtain the best results, which can be ascertained by placing a watch on the sounding box and the receiver to the ear while adjusting.

A further adjustment for the strength of current can be made by altering the relation of the carbon blocks to each other; the binding screws forming a pivot around which they may revolve, when brought closer together more current is allowed to pass, while by separating them it is reduced. This arrangement, therefore, provides two adjustments—one for making the contact or connection, the other for regulating the current.

Secondly, regarding the effects produced. The difficulty in this instance was to obtain sounds of a suitable strength, or pitch, to obtain the best effects from so delicate an instrument. Of course a watch was the first sound-producer tested, and when all was quiet, without any other sound or movement near, it answered very well; but the playing of a piano in one part of the house, and the washing of dishes in another, disturbed everything, including the patience of the experimenter. Upon any one entering the room, walking about, speaking, coughing, touching the table or door handle, the shriek of the receiver was too much to hear; even at a distance its repeated inarticulate cry became most harassing, though only an ordinary receiver was used. After attaching a longer length of double wire, and retiring to a distant room, the sounds still retained their intensity in the receiver, every word spoken in the other room being recognizable when not too loud, and the ticking of the watch was very distinct, even to the metallic ring of the hair spring as it coiled and uncoiled at its work.



A more delicate and exhaustive test was carried on a few evenings later by the help of an assistant. Having adjusted the microphone to the best angle (by the aid of the watch and receiver), the assistant retired to a distant room with the receiver, with instructions to report results. A few words were now spoken near the microphone, but proved too loud to be understood; a lower voice produced the same results; then a whisper; after which, advancing closer to the microphone, a few deep breaths were drawn, and immediately after the first inspiration and expiration the listener called out, "That's splendid! Do it again." A few more respirations were taken, when the listener, coming back from the other room, said, "The breathing sounds very distinct, what a chest you have, and how wonderfully deep and hollow it sounds. A doctor could test people's lungs without leaving his surgery, by getting his patients to breathe near an instrument of this kind; every inspiration and expiration was as deep and clear as possible." A further test was shown by placing the hand or bare forearm on the sounding box, when a rushing sound was heard, which could be none other than the rapid circulation of blood through the veins. It is also a curious sensation to hear one's own voice in the receiver coming from another source than your own mouth.

Some very successful microphones have been constructed, but considering the cheap and simple arrangement of the one described, the results must be considered very satisfactory. The current was supplied by three small Leclanche cells, the receiver being a small adjustable watch telephone.—*The Electrical Review.*

AN APPARATUS TO SHOW, SIMULTANEOUSLY TO SEVERAL HEARERS, THE BLENDING OF THE SENSATIONS OF INTERRUPTED TONES.*

By ALFRED M. MAYER.

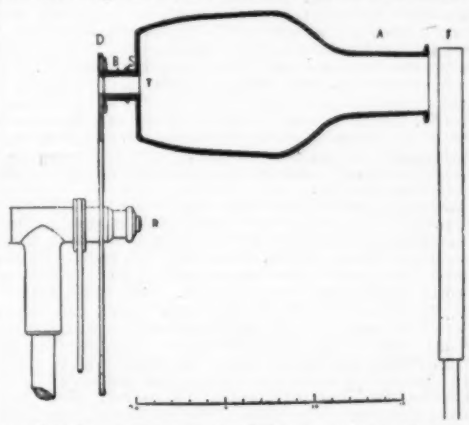
IN the January number of this journal, of the current year, I described several forms of apparatus used in my observations on the frequency of the interruptions of simple sounds required to blend these sounds and obtain from them continuous and uniform sonorous sensations. These experiments gave the data of the law connecting the pitch of a sound with the duration of its residual sensation.

The various apparatus described in that paper are, however, unsuited to exhibit the phenomena to more than one hearer at a time. To enable many hearers to observe simultaneously the phenomena I have devised the apparatus shown in the figure.

A brass tube, T, of 1·25 cm. interior diameter and 1·8 cm. long, is cemented in a hole in the bottom of the glass flask, A, which is a common form of flask, used by chemists. When the tube, T, is closed, the air in the flask resounds powerfully to the sound of an UT_3 fork, F; but when this tube is open the resonator resounds so feebly as to be just audible at the distance of several feet from the flask.

If the tube be closed and opened several times in a second, we shall have short loud sounds with faint interposed sounds. The opening and closing of the tube is effected by a perforated disk, D, revolving on a rotator, R. The tube, T, is placed in the circular path of the 16 holes which perforate the disk, with the mouth of the tube quite close to surface of the disk. A short tube, B, with flanges on it, slides neatly over the tube, T, and the flange of B is pressed against the surface of the disk, D, by the helical spring, S. By this arrangement the tube, T, is fully opened when a hole in the disk coincides with the opening of the tube, T, and is entirely closed when the flange of B is between the holes in the disk and gently pressing against its surface.

On slowly rotating the disk, while the fork is kept in vibration by an electromagnet, we have the perception of powerful beats which become more and more frequent as the velocity of rotation of the disk is increased, till, with a certain velocity, the beats blend into a smooth, continuous sound, which is that given by the fork when held near its proper resonator. This sound of UT_3 as given by the blending of its interrupted



sound is, however, accompanied by another and graver sound; but the existence of this additional sound does not interfere with the neat perception of the blending of the interrupted sound of UT_3. With this apparatus the blending of interrupted sounds has been shown to the entire satisfaction of a large audience.

To enable one readily to make the apparatus the following dimensions are given. The diameter of opening of mouth of flask is 3 cm. Depth of flask 16·25 cm. Capacity of flask, including tube, T, is 483 cu. cm.

In the figure the rotator, R, is shown driven by a cord. It is necessary, if an accurate determination is to be made of the duration of the residual sensation, to drive the disk by gearing as is done in the apparatus I have used. When the disk is driven by a cord one can show the blending of interrupted sounds, but an accurate determination of the duration of the residual sensation is prevented by the friction which exists between the flange of B and the disk, though the surfaces of these are coated with a film of oil.

ELECTROLYTIC SEPARATIONS.†

THE authors have studied the electrolytic separation of metals in presence of free nitric acid with the following results:

Mercury from Lead.—Satisfactory, provided sufficient nitric acid be present.

Mercury from Lead and Bismuth.—Unsatisfactory; bismuth was discovered at both poles.

Silver from Lead.—Satisfactory.

Copper from Cadmium—Satisfactory.

Copper from Zinc.—Satisfactory.

Copper from Zinc, Cobalt, and Nickel.—Satisfactory.

Copper from Iron and Zinc.—Satisfactory.

Bismuth from Cadmium.—Satisfactory; excess of free acid not necessary.

Bismuth from Zinc.—Satisfactory.

Bismuth from Nickel.—Satisfactory.

Bismuth from Cobalt.—Separation possible.

Bismuth from Zinc, Cobalt and Nickel.—Unsatisfactory; bismuth always contaminated with cobalt and nickel.

Bismuth from Cobalt and Nickel.—Unsatisfactory; bismuth contained nickel.

Bismuth from Cobalt and Zinc.—Unsatisfactory:

* From the *American Journal of Science*, April, 1894.

† E. F. Smith and J. B. Moyer, *J. Anal. and Appl. Chem.*, 7, 252-257.

cobalt partially precipitated along with the bismuth. Subsequent experiments showed that the separation of bismuth from cobalt, nickel and zinc was possible, if sufficient nitric acid were present.

In all these experiments the quantities of metal operated on were about a decigramme. The nitric acid (sp. gr. 1·3) added varied about 2 and 30 c. c. The total dilution 170–200 c. c. The strength of current with voltameter and electrolyte in circuit liberated 1·8–0·2 c. c. electrolytic gas per minute.

SOME FACTS ABOUT FLAGS.

By GUSTAV KOBBE.

THERE never was a more disastrous retreat than that of Napoleon's army from Moscow. Yet there were but few French "colors" among the spoils gathered by the Russians on the steppes where "General Winter," as one of the Czars grimly called the icy blasts which laid low the French veterans of many campaigns, spared a mere remnant of the great army. For the color guards were most touchingly faithful to their sacred trusts. When these men, who had faced unflinchingly many a storm of bullets, saw death by cold and hunger staring them in the face, they tore the colors from the staffs, made a fire with the latter, burned the colors, mixed the ashes with the water of melted snow, drank them, and lay down to die. Many a color guard was found frozen stiff. But where were the colors? Saved from the enemy!

The colors are not merely so many yards of silk. They represent to a soldier what is noblest in his country's history and institutions. Their loss, under circumstances short of heroic, is an eternal disgrace to the regiment losing them. Only death can excuse the color guard from defending them; and when the guard has been shot or cut down, others should be ready to stand by the flag. In the navy a vessel never strikes her colors except to acknowledge a defeat. For this reason, when, in that great sea duel between Paul Jones' Bonhomme Richard and the English Serapis, which lasted far into the night, the ensign was shot away from the halliards, Lieutenant Stafford plunged into the sea after it, and, braving a double death—he was, in fact, wounded while swimming—saved it and set it again; and it was the Serapis which finally struck. The Cumberland went down in Hampton Roads with colors flying; and when recently the old Kearsarge, which sent the Alabama to the bottom, struck on Roncador Reef, in the Caribbean Sea, and her crew was obliged to take to the boats, the ensign was left fluttering in the breeze.

Next to our own flag, that of Great Britain interests us most. It is called the "union" flag because it is three flags in one. The flag of England is a red cross on a white field; that of Scotland, a white St. Andrew's cross on a blue field. These flags were combined when England and Scotland united in 1603; and on the union with Ireland, the Irish flag, a red St. Andrew's cross on a white field, was added. The union of the three countries is thus indicated on the "union." The St. George's cross of England remains as before, and is the central feature of the flag, dividing it into four quarters occupied by the St. Andrew's crosses, the white of Scotland and the red of Ireland, which are placed side by side.

Aboard a British war ship the "union" is hoisted only when the Queen or an admiral is aboard. English ships sail under the British ensign, of which there are three kinds—white, blue and red, each with the union in a square in the upper part of the hoist—that portion of the flag along the staff. The navy, and by special permission, the Royal Yacht Club, sail under the white ensign, which has, besides the union, the red cross of St. George over the whole. The blue ensign is a privilege allowed to those merchant ships which are officered by members of the naval reserve, and one-third of whose crews belong to the reserve. It is also flown by a few yacht clubs. The red is the merchantmen's ensign. Until 1864 the British naval fleet was divided into three squadrons, each in command of an admiral, who was known, by the color of his flag, as the "admiral of the blue," the "admiral of the red," and the "admiral of the white." This distinction was abolished, because it was found puzzling in action, and was often eliminated. Trafalgar, for instance, was fought under the white ensign. The French and Spanish ships went into action without setting their colors, but were later obliged to hoist them, so as to be able to strike them.

In 1797 a fleet of British Indiamen escaped from a squadron of French war ships by a clever ruse. The captain of one of the Indiamen hoisted Admiral Rainier's colors, and the French admiral (Sarcey), thinking he was in danger of attack from a far superior force of British war ships, put about, and, crowding on all sail, made his escape from the harmless merchant fleet. When Lord Cochrane, with the little brig Speedy, attacked the big Spanish Gamo of thirty guns and three hundred men, the Speedy having but fourteen four-pounders and fifty-four men, the Englishman knew his only chance of success lay in boarding the Spaniard. During the melee on the Gamo's deck, Cochrane ordered one of his men to haul down the Spanish flag, and the Spaniards, seeing their colors come down, thought their commander had surrendered and gave up the fight.

The royal standard of Great Britain is personal to the sovereign, and is used only by the sovereign or for decoration on royal fete days. It is quartered, the first and fourth quarters being red, with three lions, and representing England; the second quarter yellow, with a red lion, for Scotland; and the third quarter blue, with a harp, for Ireland.

The history of the American flag is too familiar to need repetition. The stars in number equal to that of the States—a star being added whenever a Territory is admitted to Statehood—form the union, the thirteen stripes representing the original States. Both national and regimental colors are used in the United States army by each regiment (except cavalry, which has only a regimental standard), and by the engineer battalion—the national colors in various sizes. The garrison flag, the largest, is used only at important posts. It is twenty feet on the hoist, with a fly of thirty-six feet, the union being one-third the length of the fly, and in depth to the lower edge of the fourth red stripe. The ordinary post flag is smaller and the storm flag smaller still. The regimental colors of the United States infantry are of blue silk, and bear in the center the arms of the United States. Below the eagle is a red scroll, with the number and name of the regiment in white. The United States artillery has scarlet regimental colors, with two cannon crossed in the center, with "U. S." in yellow above and the regimental number below. The cavalry regimental standard is a beautiful seamless yellow silk, with a four-foot fly and three feet on the lance. The arms of the United States are in blue in the center, and beneath the eagle a red scroll bears the name and number of the regiment in yellow. The United States engineers carry scarlet colors, bearing in the center a castle with "U. S." above and "Engineers" below, castle and lettering being in silver. Battles in which the regiments distinguished themselves were formerly listed on the colors and standards, but are now shown on the staffs. The national and regimental colors and standards are kept at the commanding officer's quarters, and are escorted to the color company or troop amid much ceremony, the escort being headed by the band. The color guard are selected for their soldierly appearance and qualities—men who would rather die than surrender.

The flags of the United States navy are made of American bunting thoroughly tested for strength and soaked in salt water and dried in the sun for colors. There may be some hundred and sixty flags on a United States war ship—say twenty-five foreign flags (according to the station on which she will cruise), twenty American ensigns, eleven pennants, four union jacks, twelve rear admiral's flags (if a flag ship), twenty international signals, and the remainder signal and miscellaneous flags. Ensigns (stars and stripes, of course) run in eight sizes, from that used on vessels with very long spars, such as the new Brooklyn and Minneapolis will have, and which is nineteen feet on the hoist and thirty-six feet on the fly, to the little 2·37 × 4·50 foot boat flag, too small to sport more than the original thirteen States in its union. The No. 1 union jack is the 10·20 × 14·40 foot union of the No. 1 ensign, and the other jacks conform similarly to the unions of the corresponding ensigns. When a captain puts his ship into commission, he hoists, in addition to the ensign, a pennant. This has a fly of seventy feet, the union occupying 17·50, with thirteen stars. The admiral's and vice-admiral's flags of the United States navy, when these ranks are filled, are blue, with four and three white stars respectively. It will be remembered from the Columbian naval review, when our fleet was divided into three squadrons, each in command of a rear-admiral, that we preserve the old English distinction of the blue, the red and the white flag. The Secretary of the Navy flies a blue flag with four white stars, an anchor and cable, the assistant secretary reversing the colors. The President's flag is blue, with the arms of the United States, the eagle and stars white, the shield preserving the "tinctures."

The red and white crossed flag of Denmark is the oldest existing national color, having been in use since 1219.—*The Outlook.*

THE MAKING OF DIAMONDS.

By VAUGHAN CORNISH, M.Sc., F.C.S.

THE reproduction of the diamond by M. Moissan has put the coping stone to the work of mineralogical synthesis. For some years past it has been thought that the solution of this problem was merely a matter of time and patience; but it is no little satisfaction to be able to say at last that the thing has been done, for it is indeed a striking illustration of the power over stubborn matter which is won by the patient student of science. In the light of what has now been accomplished, it may not be without interest to refer to what was written in this journal on the subject of the production of diamonds previously to the work of M. Moissan. In *Knowledge* for May, 1891, at the conclusion of an article on "The Artificial Production of Rubies," the matter was referred to as follows:

"The great problem in the artificial production of gems is the preparation of the diamond. . . . In the case of other minerals the successful production has generally only been achieved after a minute study of the mode of natural occurrence, and this has afforded guidance as to the best means of imitating the natural process of formation. It is only of recent years that the diamond has been found in its original matrix, so that materials have been wanting on which to base experimental methods. The chemical nature of the body, a combustible substance, is so different from that of the ruby and most other gems, which are oxides or oxidized materials, that the methods to be employed for its production will probably involve the application of different principles. There is no reason, however, to regard the problem as insoluble. When sufficient guiding data have been obtained, skill will not be wanting to imitate in the laboratory the conditions under which nature has worked in the formation of this most beautiful product of the mineral world."

What some of these determining conditions might be was indicated in a subsequent paper on "The Diamond Mines of South Africa," which appeared in *Knowledge* for October, 1891. "To the mineralogist the chief interest of the South African mines lies in the fact that the 'blue rock' or kimberlite appears to be the original matrix of the diamond. . . . It is worthy of note that a black shale forms one of the surrounding rocks and pieces of this shale have been found baked and otherwise altered in the blue rock. The suggestion has been thrown out that the diamonds were formed by the alteration of the carbonaceous matter of the shale *under the influence of a moderately high temperature and great pressure*. Such indications are useful as affording suggestions to the experimentalist, to whom, in spite of previous failures, we must look to tell us definitely how the diamond is formed."

If the diamond be highly heated in the presence of oxygen it takes fire, as is well known, and burns with the formation of carbonic acid. If it be heated not in contact with oxygen it swells up and blackens, reverting to the ordinary charred form of carbon. But the action of heat upon bodies is in many cases very different when they are subjected to high pressure, a principle established by Sir James Hall more than one hundred years ago in his celebrated research on the conversion of chalk into marble, one of the achievements of experimental geology, described in *Knowledge* for July, 1891.

As will be seen, M. Moissan invoked the aid of pressure to modify the action of heat in his experiments and produced diamonds from charcoal, a substance of the same nature as the "shale" which occurs in the Kimberley rock. The formation of crystals is, as a rule, best brought about either by sublimation or by cooling a solution. Carbon, however, cannot be distilled or sublimed, and is insoluble in all ordinary solvents, such as water or aqueous solutions of acids and alkalies, or in liquids such as alcohol, ether or benzene. On the other hand, molten metals can take up or dissolve carbon to a not inconsiderable extent, as happens, for instance, in the well-known process of iron smelting. The molten iron in the blast furnace dissolves some of the carbonaceous fuel, a part of which, when the iron is allowed to cool and solidify, crystallizes out in plates of graphite.

This is an example of the production of a crystalline form of carbon from a non-crystalline variety, and it is, at the same time, an instance of the artificial formation of a mineral.

M. Moissan, in his experiments, employed iron as a solvent for carbon, which was in the form of charcoal; but he modified the action of heat and the solvent by subjecting the carbon-saturated iron to considerable pressure. It may be noted here that M. Moissan finds the principal constituent in the ash of the native diamond to be oxide of iron. It is known also that native diamonds often contain liquefied gases in cavities of the crystal, and that they are sometimes liable to spontaneous disruption, owing to a state of strain which is probably due to their having been formed under high pressure.

In an earlier series of experments, iron melted by means of an electric furnace, and raised to a white heat, was allowed to saturate itself with carbon in the form of strongly compressed sugar charcoal. The crucible in which the operation was conducted was then plunged into cold water, which cools the outer portion of metal so as to form an outer layer of solid iron. While this outer coating is still red-hot the crucible is withdrawn from the water, and the cooling proceeds more slowly. To realize what goes on within the jacket of solid iron, we must remember that the still liquid interior is molten iron, containing a large excess of dissolved carbon, and that iron expands in the process of solidifying. Hence, during the process of solidification within the jacket or crust of chilled metal, great pressure is exerted. The process of solidification, therefore, goes on slowly and under great pressure, and examination of the resulting product showed that, under these changed conditions, a part only of the surplus carbon had crystallized out as graphite, and that in the residue left after dissolving away all the iron by means of boiling hydrochloric acid and other solvents there was a certain quantity of a denser form of carbon (having a specific gravity of 3 to 3·5), and hard enough to scratch a ruby; and that among these heavier portions of the residue were transparent particles, having a greasy or waxy luster and marked with parallel striæ and triangular depressions.

These transparent particles burned when heated to 1,050° C. in oxygen gas and, as it appeared, with the formation of carbonic acid; but the particles were too small to allow of a quantitative experiment. Similar results were obtained by the slightly modified method of rapidly cooling an ingot of molten iron saturated with carbon from a temperature of 2,000° C. In a few cases small fragments were obtained, "qu'ils ressemblent aux petites fragments de diamant transparents que nous avons rencontres dans la 'terre bleu' du Cap" (*Comptes Rendus*, February 6, 1894). The result may be summed up by saying that, up to the date of the experiments described in the above quoted paper, M. Moissan appears to have succeeded in reproducing that transparent variety of carbon of which native diamonds are composed. The specimens could hardly be called diamonds, although they showed certain characters of the native diamond—*e. g.*, a waxy luster, and parallel striæ and triangular depressions on the surface.

Since the experiments above described, a happy modification of the method employed has given results of a far superior kind, perfect diamonds being formed, having the distinctive physical peculiarities of the native stone and of sufficient size for M. Moissan to prove by quantitative chemical experiments upon some of the specimens that they burned with the formation of pure carbonic acid. In the course of experiments made in former years by other experimenters using other methods, transparent crystalline bodies were obtained which were thought to be diamonds, until their failure to satisfy the carbonic acid test showed that the crystalline particles were not composed of carbon.

Moissan's modified method is as follows: Iron is saturated with carbon at the white heat of an electric furnace and under pressure. The crucible containing the molten iron is then quickly lowered to the bottom of a bath of melted lead.

This insures quicker cooling than when the iron is plunged in water, owing to the fact, first, that the white-hot iron does not really come into contact with the water; and secondly, that the lead is a good conductor and carries away the heat rapidly. It seems that the two liquid metals behave toward one another much as oil and water, and the molten iron collects in spherical globules which rise to the surface of the molten lead, the difference in the specific gravity of molten iron and of molten lead being, of course, very considerable. The surface of the drops of liquid iron which float upon the surface of the lead quickly solidifies, the smaller drops with a diameter of one to two centimeters first, the larger drops after a lapse of a longer time, and the solid little balls of iron are left to float on the molten lead, where they cool down. The interior of the balls is of course liquid long after the formation of the solid crust.

The tendency of the central parts to solidify is resisted by the solid crust, owing to the fact before mentioned, that iron expands in the act of solidification. Meanwhile a part of the carbon crystallizes out from its solution in the liquid iron. After a time, as the cooling goes on, the lead also solidifies, and the little iron balls are left embedded in the ingot of lead. Then begins the process of getting at the small quantity of the carbonaceous material which it is desired to examine. The lead which adheres to the iron is dissolved away with nitric acid; the iron itself is dissolved by hydrochloric acid, and further treatment with suitable solvents leaves the sought-for residue, a small quan-

tity of material left after the tedious process of removing by slow chemical means the relatively large mass of metal.

Transparent diamonds are found in the residue having well-defined crystalline faces, striated and marked in the well known way, and the edges generally curved; they have the high refracting power, the specific gravity and the hardness of the native stone. The peculiar form known as the hemihedral predominates among these crystals as in those of native diamonds, and their formation under pressure is found to give rise to the phenomena of anomalous polarization of the light which passes through them, as well as occasionally to spontaneous disruption; characters which, as has been mentioned, are sometimes noticed in the native stone. The diamonds are of course small; one with a diameter of half a millimeter appears to be reckoned a fine specimen.

Further practice in working the process will probably enable larger specimens to be obtained, as has been the case with the production of rubies, which are now produced of a size sufficient to be used in the jewelling of watches.

However this may be, the production of diamond is now an acknowledged fact, achieved by the patient skill of the same worker who, seven years ago, successfully overcame the great experimental difficulties which had rendered fruitless the many former attempts to isolate the chemical element fluorine.—*Knowledge.*

CRUDE CARBOLIC ACID.

By H. W. JAYNE, Ph.D.

THE composition and methods of preparation of the crude carbolic acids of commerce appear to be so little understood by pharmacists generally that it seems as if a few remarks about them, from one who has practical knowledge of their manufacture, might be of interest to those present.

Many text books state that crude carbolic acid is prepared by repeatedly distilling a portion of the coal tar, until a fraction is obtained boiling between 170–190° C., which is then extracted with a strong solution of caustic soda. This method is not used at present in large works either here or abroad.

While it is possible to obtain a fraction rich in acids by repeated distillation, yet the total yield is less, for a certain amount is lost in each distillation, either by volatilization, or being destroyed by contact with the heated sides of the still.

In this country, as a rule, the tar is distilled in two fractions. The first, consisting of all the lighter portions, is called the light oil, and is collected until a sample of the oil that runs from the still sinks in water. The whole fraction when mixed has a gravity of from 0·94 to 0·99. The second fraction, consisting of about 20 per cent. of the tar, constitutes the creosote—or heavy oil—commonly called dead oil. The residue left in the still is soft pitch. In some cases the first portions of the dead oil are collected separately, in order to obtain a fraction as rich in acids as possible, which is then known as carbolic oil. The light oil, which boils between 90° and 250° C., contains from 4 to 10 per cent. of acids, and therefore nearly all of the carbolic acid, or true phenol, *boiling at* 182°.

The dead oil contains from 10 to 20 per cent. of acid, the carbolic oil, if made, sometimes shows as high as 30 per cent. The oils contain also a certain amount of carbolic acid, but the proportion is much less than in the light oil.

In Europe, where most of the crystal carbolic acid is made, the fractions are collected differently. The first portion running from the still, containing most of the benzol and toluol, is called crude naphtha or first runnings. The second portion, which is collected as long as the distillate is lighter than water, is called light oil or second runnings, and is very rich in phenol. The third fraction constitutes the carbolic oil. The portion to be extracted is agitated with a weak solution of caustic soda, about 10 per cent. is the right strength. If a strong solution is used, many impurities contained in the oils, especially naphthaline, are also dissolved and contaminate the finished acid. After agitation the mixture on standing separates into two layers—the upper consisting of the extracted oil, the lower the solution of carbolate of soda. This latter is drawn off, and on acidifying with either sulphuric or hydrochloric acid, the tar acids are liberated, and float on the surface as an oily layer, holding more or less water in solution, depending on the nature of the acid present. For convenience in consideration, we will arbitrarily divide the crude acids into two classes.

(1) Crude acids for the manufacture of crystal carbolic acid.

(2) Crude acids for disinfecting purposes.

Acids of the first class are not a regular commercial article in the United States, as there is only one firm manufacturing crystal carbolic acid, but in Europe, especially in England, they are prepared on a very large scale. As their value depends on the amount of crystal acid they contain, they are sold by test. Crystal carbolic acid being the first of the series of phenols, has the lowest boiling point. Therefore, the boiling point of a crude acid is to a great extent an indication of its value.

In England, an arbitrary method has been devised by Lowe, which gives an approximate idea of the value of these acids. A sample (say 100 c. c.) is distilled in a retort or flask. At first water passes over, then an oily liquid.

When 10 c. c. of this latter have been collected, the receiver is changed, and the next 62½ c. c. collected apart. The residue in the retort is cresylic and higher acids. The 62½ c. c. obtained as a second fraction is cooled, and the solidifying point ascertained by a thermometer placed in the liquid. These crude carbolic acids are sold as 50°, 60° or 70° acids, meaning thereby that the second fraction of 62½ c. c. crystallizes at 50°, 60° or 70° F. That containing the most crystal acid showing the highest melting point.

A good quality of 60° English crude carbolic acid distilled as follows:

	Per cent.	
To 180,	17	(11 p. c. water)
" 185,	21	
" 190,	71	
" 195,	88	
" 200,	93	
" 205,	95	

The portion representing the 62½ c. c. distilling between 184¾° and 193°.

A very good grade of light oil must be used to obtain such an acid; if a higher fraction of the tar is extracted, the acid obtained shows a correspondingly higher boiling point.

The following acid was extracted from the first portions of the dead oil:

	Per cent.	
To 180,	14	(11 p. c. water)
" 190,	20	
" 195,	55	
" 200,	74	
" 205,	82	
" 210,	88	
" 220,	91	
" 230,	93	

The 62½ c. c. of this acid did not crystallize until cooled to 25° F. If insufficient soda is used, it would be possible to extract, even from an oil of this nature, a certain amount of acid rich in phenol. Phenol has a greater affinity for soda than its homologues; therefore, if one-half the soda necessary for complete extraction is used, the solution will contain a greater proportion of phenol than if the material were extracted completely.

This is clearly shown by the following experiment.

A sample of oil was treated with three equal portions of weak caustic soda solution, the last portion extracting the oil completely.

Each solution was neutralized with sulphuric acid, and the resulting acids distilled. In order to show their composition more clearly the result is calculated after deducting the water present.

Acid from:

	First Portion. Per cent.	Second Portion. Per cent.	Third Portion. Per cent.
To 180,	6	—	—
" 185,	30	—	—
" 190,	74	1	—
" 195,	86	41	2
" 200,	91	71	16
" 205,	94	83	54
" 210,	—	87	74
" 215,	—	91	84
" 220,	—	—	88
" 225,	—	—	92

The first portion is equal to a 60° acid, and contains a large amount of phenol; the third portion, none at all. To prepare crystal acid from these crude materials, they are carefully rectified in large iron stills, the watery portions separated, and the fra tions from (say) 180° to 190° cooled, the phenol crystallizes and is drained from the liquid portions. The crude crystals thus obtained are then carefu ly refined. As the crystal carbolic acid has a much higher value than the other acids, it is in the interest of the manufacturer to remove it as completely as possible. The remaining liquid acids are sold as "crude carbolic acid 100 per cent." as they are entirely soluble in caustic soda solution, excepting traces of naphthaline and other impurities.

The lowest grades of crude acids, known as 10, 15, 20 and 25 per cent., are simply unextracted portions of the heavy oil, containing this amount of tar acids. The higher grades, 50, 60 and 70 per cent, are prepared by adding 100 per cent. to the lower grades.

As the heavy oils used in mixing these acids contain a large number of bodies, these are of course present in the commercial acids. The most important of these are the pyridine bases and naphthaline. The former gives to certain acids a rank, disagreeable smell. The latter is generally present in large amounts, some oils consisting of more than half crude naphthaline. In cold weather this naphthaline is deposited, and as the liquid portions are drawn off, it finally remains in the barrels as an oily mass, which will not again become liquid, thereby occasioning a serious loss to the purchasers. It does not appear to be generally understood that these acids consist largely of oil, for it is a common occurrence to find disinfecting acids in bottles, labeled with directions for mixing with water, when a test shows that it is entirely insoluble in water, and contains only a small percentage of acid.

Many methods of testing crude carbolic acids have been proposed, which apparently ignore the large per cent. of oil present.

An instance of this is the method recently proposed by Seiler, and which has been extensively copied by journals throughout the country.

His method is to weigh 100 grammes of the sample in a large beaker, adding milk of lime (obtained by slaking 200 grammes of lime) and diluting to one liter. The whole is placed on a water bath and stirred for an hour, after which the same amount of water is again added, when cold it is filtered, washed with fresh water and filtered again. The acid is liberated by hydrochloric acid, salt being added to the solution to remove as far as possible the acid dissolved in the liquor. It is then separated and weighed. He sums up the result of his investigation by stating that an acid sold as 25–30 per cent. showed only 2 to 3 per cent.; a 40–60 per cent. acid gave 3 to 5 per cent.; a 50–80 per cent. and a 90–100 per cent., 80 per cent. From this he concludes that commercial acids contain considerably less than stated, and that the lower grades are worthless.

To one acquainted with the nature of crude carbolic acids, the defects of this method are at once apparent. The slaked lime on mixing with the acid forms an oily mass, from which it is nearly impossible to extract any acid. Lime is too weak a base to extract the last portions of acid from the oil, and the voluminous liquid, amounting with the wash waters to about three liters, dissolves a large percentage of the acid even when saturated with salt.

It will be noted that the crude acid said to contain the larger amounts gave better figures than the low grades, which was to be expected, as there was about the same amount dissolved in the salt solution from that acid that should have given 25 c. c. of acids as from that which should give 100 c. c.

As these crude acids are only for disinfecting purposes, and as cresylic and the higher acids are now recognized to have the same, if not better, disinfecting properties than phenol, it does not seem necessary to determine any other point than the total per cent. of acid they contain. No simpler method can be devised than the well known one of shaking a certain quantity of the material in a graduated vessel, with weak caustic soda, and noting the decrease in volume. To verify the result the soda solution can be acidified and the tar acids measured. The amount liberated is always less than that indicated by the decrease of the volume of oil, owing to the solubility of the acid in the salt solution.

For this test I would recommend a 100 c. c. burette, divided in tenths, and furnished with a glass stop cock. It is filled to the 50 c. c. mark with 10 per cent. of caustic soda solution; 25 or 50 c. c. of the acid to be tested is then added, the burette closed with a cork and well shaken. On allowing to stand, the decrease in the volume of oil is readily measured; 50 c. c. soda of the strength indicated is sufficient to saturate 12 c. c. of 100 per cent. acid. If it is necessary to add more soda, the already saturated solution can be readily drawn from the burette and another 50 c. c. added.

Frequently the percentage of naphthaline in low grade acids is so great that it separates from the liquid as soon as the acids are removed; as this prevents an accurate reading, it is necessary to add 10 to 15 c. c. of benzol to dissolve the deposit.

In some cases the acids are contaminated with tarry or resinous bodies, which dissolve in the caustic soda, rendering the solution so dark that it is impossible to see the line separating the two liquids. In this case it is advisable to distill another 25 c. c. portion nearly to dryness in a small flask, considering the distillate as 25 c. c., and repeating the test. The entire operation requires but a few minutes, and the results of many hundred trials show it to be accurate enough for general purposes.

A mixture of equal parts of heavy oil and cresylic acid was made, and tested by the above method. The contraction showed 49½ per cent. of acid present, the liberated phenols gave 49 per cent. The same mixture tested by Seiler's lime method gave only 22 per cent., every precaution being taken to insure a good result.

Another mixture prepared with 25 per cent. of acid gave 24½ per cent. by extraction, and 24 per cent. of phenols set free. The lime method gave but 6 per cent.

The Pharmacopœia requires that 50 volumes of a crude acid mixed with 950 parts of water should not leave undissolved more than 5 volumes or 10 per cent. It is difficult to understand for what reason such an arbitrary test is required. Fifty c. c. of insoluble residue in 1,000 c. c. of solution is difficult to measure with accuracy, particularly as the acid often adheres in fine globules to the sides of the measure. This may seem a small objection, yet it is very important when the acceptance or rejection of a large lot of acid depends on it.

A sample of excellent 60° crude carbolic acid was tested by the method of the Pharmacopœia, and answered its requirements, about four volumes remaining undissolved. Another portion of the same acid was then distilled to remove the small amount of tarry matter and about 11 per cent. of water present. This fine light colored acid showed by the Pharmacopœia test fifteen volumes or 30 per cent. insoluble. In other words, an acid containing all the best portions of the first sample and having 15 per cent. more value as a disinfectant, would not stand the test.

A sample of distilled cresylic acid, free from water, distilling to

	Per cent.
190	12
195	70
200	88
205	97

gave 25 volumes or 50 per cent. insoluble. It was found necessary to add 75 per cent. of crystal carbolic acid (melting point, 35°) to 25 per cent. of the above cresylic acid, before a mixture could be obtained which would give a satisfactory result.

As the Pharmacopœia requires an acid for disinfecting purposes only, and not for preparing crystal acid, it is useless to require such a high per cent. of phenol, and it would be undoubtedly to the purchaser's interest to buy an acid free from water. If the idea is to prevent the use of the higher boiling phenols, which are very little soluble in water, the difficulty could be overcome by the following requirements:

It should not be soluble in less than 15 parts water at 15° C., and the aqueous solution should not have an alkaline reaction. It should dissolve in 10 per cent. caustic soda solution, leaving not over 5 per cent. insoluble. Should not show over 2 per cent. water, and 90 per cent. should distill under 225° C.—*Am. Jour. Pharm.*

CHLORIDES OF SODIUM AND POTASSIUM.

By T. PARKER and A. E. ROBINSON, of Wolverhampton.

IN the electrolysis of chloride of sodium and chloride of potassium caustic soda and caustic potash are formed, respectively, at the negative pole, and chlorine gas is liberated at the positive pole; but the full electro-chemical efficiency of the reaction has not heretofore been obtainable, owing to the tendency of the two ions to recombine. The object of this invention is to provide means to be employed in connection with the said electrolysis, whereby or through the medium of which the electro-chemical efficiency is increased and useful products obtained. This is effected by removing the caustic alkali from the sphere of electrolytic action by combining it with oleic, stearic, margaric or other organic fatty acid, which in consequence of the lower specific gravity of the compound which is thereby formed, and its insolubility in the electrolyte, rises to the surface in the cathode compartment, and can be removed therefrom as may be convenient. The acids may be added as oils or fats, such as tallow, olive oil, cottonseed oil, palm oil or the like, in which the fatty acid is combined with glycerine, or the acids may be used after they have been separated from the glycerine. Or the electrolysis of the solution may be continued so long as an amount of caustic soda (or caustic potash) is formed practically corresponding with the theoretical amount obtainable for the amount of electrolytic action expended, then the solution removed and the caustic soda or potash contained therein converted into the insoluble compound before mentioned, after which the electrolysis of the chloride so-

lution is proceeded with as before. The soap compound made as above described may be used as soap or for any purpose for which it is suitable, or the compound may be treated with carbonic acid gas and the fatty acid thus recovered from it, while the alkali is converted into a carbonate.

FAVE'S DIVING TIDE GAUGE.

IT is now nearly three years ago that Mr. L. Fave presented to the French Society of Physics the interesting apparatus that we propose to describe. The reason that we have not done so sooner is that we have been waiting for it to assume its definite form as a result of the experiments to which it was to be submitted. It has, in fact, been sensibly improved during these three years without the principles upon which it is based having been in any way modified.

The tide gauges permanently installed in a few ports of the coast are excellent, faithful and easily maneuvered instruments, but it is not always possible to make use of them. They necessitate, in fact, a structure whose lower part shall be always washed by the rising tide, and do not lend themselves to a flying installation, upon a strand or even upon a cliff. The scales that may be fixed at a short distance from the coast are liable to be destroyed by the tide or by the malevolence of the shore dwellers, even in civilized countries, and, moreover, as an observation of them, at sufficiently approximate intervals, is very necessary, it would be advantageous to substitute the use of a registering apparatus therefor. Finally, none of the tide gauges known permits of observations in an offing, at somewhat considerable depths. It will be seen, nevertheless, how great an interest attaches to such observations, since the coast has a very great influence upon the tide.

It is to such multiple *desiderata* that the Fave instrument responds. This gauge does not, like those with which we are familiar, register the height of the water, but the pressure, or, more exactly, the variations of such pressure, through a very ingenious mechanism. Upon the whole, it is nothing more than a sea bottom barometer.

In its definitive form (Fig. 1) it consists of two Bourdon tubes fastened to blocks that remain fixed in a same series of observations, but the position of which can be regulated through adjusting screws. Their movable extremity carries flexible strips, L, each of which is provided with a very fine point, P. The pressure of the water, transmitted by the tube, C, opens the spirals and separates the points, one of which moves forward and the other backward. It is the motion of these points that is inscribed. To this effect, a disk of glass, V, covered with varnish and carried by the pillar plate of a clockwork movement, revolves in front of the points, which leave a trace of their passage in the varnish. The very judicious use of two points instead of one point renders the result independent of the centering of the glass disk. It suffices, in fact, to measure the variations in the spacing of the two lines in order to completely eliminate the imperfections of the apparatus. The two small handles that carry the letters, A and B, serve to press the points against the disk or to separate them from it by means of inclined planes that engage under the flexible pieces, L and L. The entire apparatus is contained in a box, and the interior of the spirals alone communicates with the surrounding medium.

The inscription of the very feeble motion of the points presents peculiar difficulties. The lines must be extremely fine if it is desired to obtain precise results. Silvering gives satisfaction in this respect, but it rapidly blackens, and the lines soon become invisible. Lamp black is difficult to use, and aniline colors are too hygroscopic and the least condensation of moisture clogs up the lines. Nitrate of rosaniline, which is but slightly soluble in water, lends itself to tracings whose fineness is limited only by that of the points. A saturated solution of it is made in concentrated alcohol, say 2·2 grammes to 100 cubic centimeters of alcohol and 10 cubic centimeters of ether. The solution is spread over the disk, which is turned up vertically and exposed to heat until dry. The thickness is varied by modifying the proportion of ether.

Such as we have just described it, the apparatus is perfectly adapted for depths of about ten meters, but when it is desired to submerge it to greater depths, there are two difficulties encountered; if the spirals are thin, they become too much distorted, and if they are too thick, they no longer visibly inscribe the variations of level.

Mr. Fave has solved the problem by causing only a part to act, and, so to speak, only the variations of the pressure of the apparatus. The artifice employed by him is identical in principle with that upon which is based the Richard statoscope, but it is applied in a very different manner.

For experiments at depths of more than ten meters, the apparatus is inclosed in a metallic cylinder (Fig. 2, No. 2) provided with an aperture at the lower part. It is put in communication with a rubber bag filled with air, through the intermedium of a tube passing under a clamp external to the apparatus (Fig. 2, No. 1). This clamp consists simply of a piece of wood pressed upward by a spring. A coun erpoise keeps the clamp open. The water, gradually entering the cylinder, compresses the bag, and the air, forced into the box of the apparatus, balances the pressure in the interior of the spirals at every instant. When the vicinity of the bottom is reached, the weight deposits, the rubber is compressed and the pressure in the box remains con-

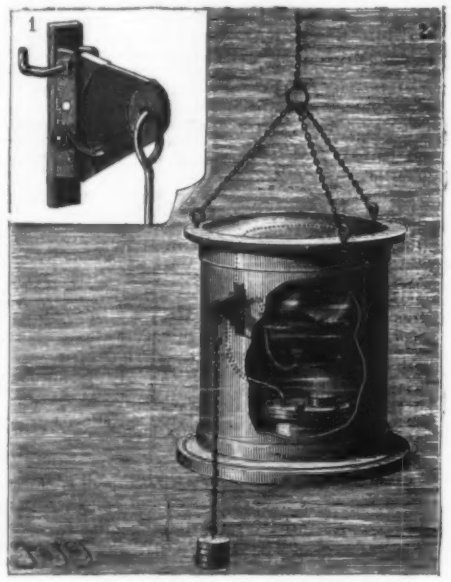


FIG. 2.—FAVE'S TIDE GAUGE.

1, clamp; 2, apparatus inclosed in a metallic cylinder.

stant from this moment. The apparatus is thus in the same conditions of sensitiveness as if it had above it a column of water equal to the length of the chain that supports the weight. The rubber forms at the point where the clamp is situated a curve into which a drop of glycerine is introduced in order to assure a perfect closing.

The apparatus is so constructed that the disk makes one revolution in two days, but it is useful to inscribe the tides at the same place for eight days at least. The use of the two movable points permits of superposing several periods upon the same disk, for the lines always intersect each other at an angle sufficiently wide to allow them to be followed without ambiguity.

We shall finish by citing one of the results obtained with the apparatus. At 200 kilometers, at least, from Brest, and at a depth of 150 meters, it was found that the tide had an amplitude about half less than at the coast. The result cannot be given in precise figures, since, in this experiment, the operation of the apparatus was perturbed by a leakage. But the measurements are going to be taken again, and will doubtless enlighten us as to the delicate question of the action of the coasts upon the tide.—*La Nature.*

CONTAGION AND PHTHISIS PULMONALIS.

By Sir BENJAMIN WARD RICHARDSON, M.D., F.R.S.

As if to discount good influences of a true hygienic character in reducing the death rate from phthisis pulmonalis, some enthusiasts, in writing on the contagion speculation, have endeavored to show that the lessened mortality from the disease, observable during the past few years, is due to the influence of the doctrine of contagion. Dr. Lawrence Flick, of Philadelphia, has written in this strain in the *Medical News* for May 14, 1892. He calculates that the actual decrease of deaths from phthisis in Philadelphia, from 1881 to 1891, is 0·734 per thousand of living people, which, with the present population, shows a saving of 784 lives a year. The result he assumes to be due to the circumstance that members of the medical profession in Philadelphia, having become converted to the hypothesis that phthisis pulmonalis is spread by contagion from particles of dried sputum derived from patients affected with the disease, have taken care that such contagious matter shall be at once destroyed, and so have prevented the spread of the disease by communication. It is astounding how speculations of the kind named are supported on coincidences. There is a physician living in this country who, with equal argument, believes that the reduced mortality from the disease in question is due to a medicinal cure for the disease which he himself has introduced. To prove the beliefs of such advocates, it would have to be demonstrated how many practitioners have prescribed the means of prevention or cure specified, and how many times their suggestions have been practically acted upon. Impossible demonstrations! As to the first—the conversion of the profession to the hypothesis of contagion and the influence of that conversion in modifying the death rate—it is the simplest truth to say that if the profession in Philadelphia is at at all like the profession here, there is not a shadow of evidence in support of the proposition. There are a few probably who, accepting the hypothesis out and out, are more particular respecting cleanliness and removal of expectoration than they were; while the many, looking at the hypothesis doubtfully, are as little influenced by it now as they ever were. Why should this not be so? The experience gathered in Naples on this subject, when the most rigid rules for destruction of all morbid material failed to render service, is not likely to be forgotten; while the majority of observers have never been able to see the evidence that would establish the hypothesis. Let me take in illustration my own experience. In my student life I was under an able teacher of the practice of medicine, the late Dr. Andrew Anderson, of Glasgow. In his lectures on phthisis, he entered carefully into the contagion theory, at that date—1846—rather popular. He held a wise reserve on his own part; but he told us the question was a vexed one, and he urged us all to watch most carefully for ourselves in our future lives. I was one who determined to watch intently, without bias—how could I have any occasion for bias?—and persistently. I have sustained my watchfulness in the same spirit from then until this day, *i. e.*, over a period of nearly fifty years. Every opportunity has been afforded me for watching. I entered early in life into the experience of a large general practice; I left that for physician's practice in London. I became physician to an infirmary for diseases of the chest, situated in a densely populated part of London. I held my post for about fourteen years, rising to the senior physicianship. During a part of this same period I acted as one of the physicians to the Metropolitan Dispensary, the Blenheim Street Dispensary, and the Margaret Street Dispensary, another institution for the treatment of consumption. This was a wide field for practice and for observation. Moreover, at these institutions, where I gave systematic instruction, I was fortunate in having able assistants, who kept careful notes of the cases under treatment. In the course of the period named, no fewer than three thousand patients suffering from phthisis came before me; and during all the time the question of evidence on the point of contagion was never for a moment lost sight of. It is the fact that in all this field of practice not a single particle of evidence ever came before me that sustained the contagion theory, or gave, on reliable data, the least color to it. No professional brother, no assistant, no nurse, no person connected in any way with the phthisical sick, ever afforded indication of having received the disease by communication; and it is worthy of remark that no physician of my acquaintance, in the days I speak of, ever expressed a suspicion of communication by contagion. In the fifties, we had in London a society for the special study of chest diseases. In it were men of acute observation, and of skill in diagnosis. We were all engaged in hospital practice, and we all worked earnestly. The late Drs. Baly, Snow, Leared, Sibson, Francis Webb, Risdon Bennett, Edward Smith, were members of this society, as were Sir Richard Quain, Dr. Hawksley, Dr. Cockle, and one or two more whose names escape me. We met in turn at each other's homes; we drafted patients to our meetings for careful study; we discussed every point with the utmost freedom of discussion; but I feel sure at that time not one of us entertained seriously the hypothesis of contagion. Was it that we were all blind to evidence which must have been passing every day before our eyes, evidence which should have occurred to us, apart from any hypothesis, if it existed? Was this revived hypothesis wanted to open our eyes? Or was it that when the hypothesis was once restarted those who accepted it did not really see what they had failed to see previously, but were led to adapt their discernment to the requirement and to receive what was necessary to be received in order that the hypothesis might stand on a logical foundation?

I resigned my work as physician to the special institution for diseases of the chest toward the latter part of 1867, but I have remained up to the present time profiting from another course of experience in a practice of twenty-five years. In the latter part of that time much controversy has been revived on this subject of the communicability of phthisis by contagion, and although I have taken little public part in the controversy, I have been as active in observation as ever I was, endeavoring to learn, without the least prejudice, the exact facts. For many years I have sat at a board of insurance directors, feeling all the responsibility that attaches to that official duty. In every case of phthisis pulmonalis that has come under my notice in practice, and in every case of the same disease of which I have had cognizance otherwise, I have been vigilant to arrive at the circumstances under which the first symptoms of the disease were manifested. Not once has there been evidence of origin of phthisis from contagion on which I could rely. It is true I may more than once have heard the con-

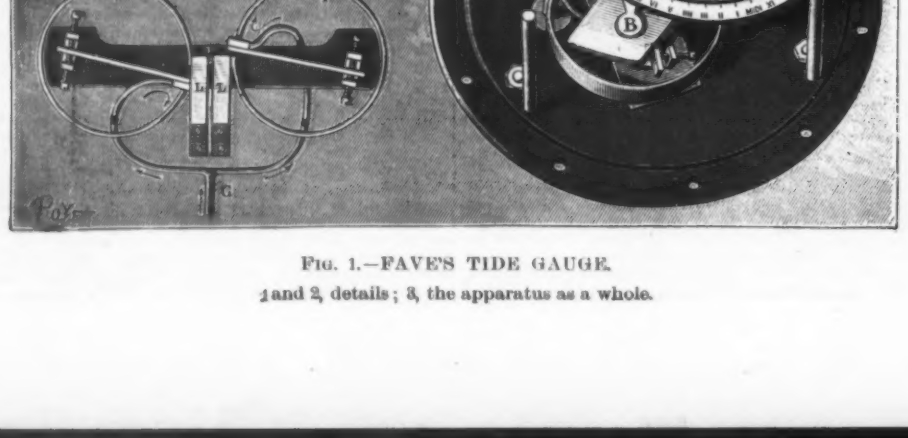


FIG. 1.—FAVE'S TIDE GAUGE.

1 and 2, details; 3, the apparatus as a whole.

elusion that some contagious influence was at work, but on further inquiry the evidence has broken down. There were living near to me two sufferers from the malady who occupied the same house. They were brother and sister, the only children of a professional friend; they had the hereditary history painfully characteristic of phthisis, and in the course of the affection in them from the beginning to the fatal end their symptoms ran so closely as to be like twin phenomena. Could there have been contagion in these cases? Many might have said so who had not taken pains to investigate the facts. To me the facts were familiar. The brother was often assisting me in my work, so that I knew his history; and his attack dated from a severe cold contracted by exposure to an intense chill at an evening party, to which he went lightly clad, and in which he added to the risk from changing portions of his dress for some much lighter ones in order to take part in a charade or play. He sent for me at once when he became ill. It was the old story of pneumonia followed by rapid tubercular phthisis. The sister at this time was many miles in the country, where she had been for several months, during which time the two had not once met each other. She, like her brother, took a severe cold; and when she came home, and passed under my care, she was in the same state of phthisis as he. In neither case was there the remotest evidence of contagion, yet because of their affinity I afterward heard it adduced that contagion was at work. Not infrequently on being called upon to prescribe for phthisical patients the statement has in late times been made to me that the disease had been contracted by contagion, but in not one instance has any proof been supplied that would in a court of law of the first instance bear investigation.

I ask naturally in conclusion, Can I be blind to open facts, or do I see correctly, and has the hypothesis of contagion blinded those who see differently from myself? Willingly I will admit myself blind, and will submit myself to any correction that will give me sight; but the correction must be supplied, and in a form that makes all so clear that he who runs may read. I must be shown one case of phthisis in which the evidence is absolute that the disease was contracted from contagion, and that it could not possibly have been produced by any other determining cause.

Returning to Dr. Flick and his argument—that the mortality from consumption in Philadelphia, or any other city for the matter of that, is reduced by the precautions taken in regard to the disposal of the sputum of afflicted persons—the point is clear enough that what he traces as cause and effect is due to nothing more than coincidence.

No sanitarian for the past forty years, to my knowledge, has doubted the fact that phthisis pulmonalis will disappear just in proportion as broad sanitary views are established and brought into practice. We have all believed, and, as we think, proved, that under new conditions, in which there is provision for a better heredity, in which cleanliness becomes the watchword of sanitation, in which the youth of both sexes can enjoy free exercise and recreation in the open air, and in which the labor of life in confined places is being reduced to a proper standard; we have all believed that with these changes the disease would die out altogether. In my Essay on the Hygienic Treatment of Pulmonary Consumption, published in 1856, these principles were so strenuously enforced that I was looked upon in enforcing them as a visionary, and as wanting in that practical acumen which was necessary for successful effort in the treatment and prevention of disease. I was not alone in that argument, but I was one of a very few. In time our principles prevailed, and the reduction of mortality from consumption in military barracks, owing to reforms which were insisted upon in our teaching, afforded direct evidence, long before this contagious idea was advanced, of the truth and correctness of our observation.

The process of purification has since then gone on by leaps and bounds, and we are beginning to see the good results; a new hypothesis springs up coincidently which may or may not be right to a certain extent within its own narrow range, but which has no more to do with the great results at this time boasted of than the reduction of typhus in its worst forms has to do with carrying of camphor in the pocket, or placing rue in the wardrobe or on the desk before the judge of assize. It may be quite practical, it is quite practical, to take care that the expectorated secretion of consumptive patients is destroyed. The late Dr. William Farr put his finger on this fact, and every sanitarian felt the importance of his advice. But this is merely a matter of cleanliness, merely a part of the whole system of perfect hygiene; and if we let this one thing stand as if it were the whole thing, we shall merely lead to carelessness in regard to everything else, and shall make matters worse instead of better. Dr. Flick is so good an observer and so earnest a man, there can be no hesitation in being critical on this particular part of his instructions, and it is only because it is painful to see him narrowing himself to one issue that this criticism is ventured upon. I hope he will take a wider view as time rolls on, and accepting the old message of the Mishna, that "Outward cleanliness is inward godliness," or, as John Wesley transformed it, "Cleanliness is next to godliness," will become a preacher of true catholic doctrine in all that relates to sanitation and the physical welfare of the world.—*The Asclepiad.*

AUGUST HIRSCH.

AUGUST HIRSCH, the founder of historical-geographical pathology, died in Berlin January 28, after a long illness. He was born October 4, 1817, in Danzig, and studied in Berlin and Leipzig. His career was influenced particularly by Hecker, the historian of medicine, and Schonlein, the clinic professor. He graduated in Berlin in 1843, his thesis being on the subject of croup, and after having taken the state examination, he began practice. This did not prove entirely satisfactory to him, and he thought of entering the Dutch East Indian Colonial service; he was, in fact, in the Hague, ready to enlist, but was prevented from taking the final step by the advice of a German physician who had had disagreeable experiences in this service. This plan, however, affected his whole future, for he had begun the study of medical geography in order to be prepared for medical service in the Indian Colonies. He first interested himself in malaria, the most common of tropical diseases, and then in the relation of malaria to tuberculosis which was then supposed to exist. Later he occupied himself with diseases of the typhoid type.

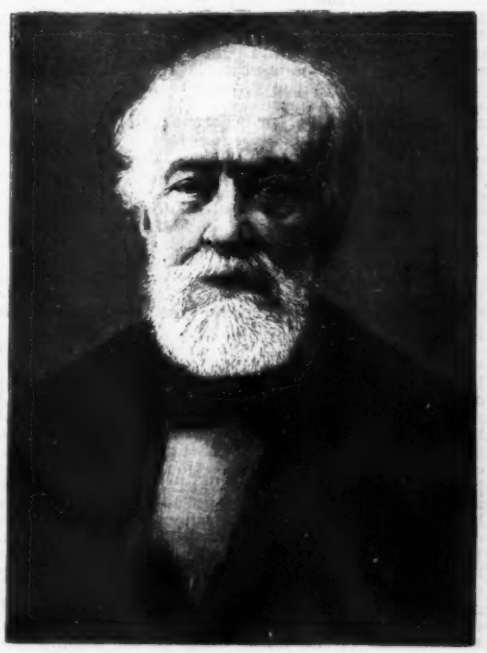
In further pursuance of these studies he entered upon a new undertaking, the study of diseases from a geographical and historical point of view. To be sure there had been some investigations of this nature which would serve as stepping stones to a historical pathology, but Hirsch's work was of a different nature; he showed the organic connection of geographical medicine with researches in the history of medicine. His "Handbuch der Historisch-Geographischen Pathologie" (Handbook of Historico-Geographical Pathology) appeared first in 1860–1863, and again, fully revised,

AUGUST HIRSCH.

in 1880–1884, and caused a great sensation, but the author would have continued to occupy the modest position of a practicing physician in Danzig, if he had not been called to the Berlin medical faculty. Here he found his proper field for work. The faculty immediately began to study hygienics, and Hirsch, whose researches in regard to epidemics were well known, was the adviser of the administration, which sent him to West Prussia to study cerebro-spinal meningitis, to West Prussia and Posen to study cholera and to Astrakhan to study the plague. He also took a prominent part in the cholera convention. It is true that later, after the dawn of the bacteriological era, Hirsch no longer stood in the foreground as adviser. But the change in the state of affairs did not prevent his recognizing the importance of the study of bacteriolgy in connection with hygiene, although he earnestly warned the profession against the error of attributing epidemics exclusively to this cause. Much of his time was occupied in editing the "Jahresberichte uber die Fortschritte der Medecin" (Annual Report of the Progress of Medicine), the "Biographical Lexicon," and the "Allgemeine Deutschen Biographie" (Universal German Biography). He also found time to write "Geschichte der Medicinischen Wissenschaften" (The History of Medical Science), which, with the "Historisch-Geographischen Pathology," will secure Hirsch a lasting fame. For the portrait of August Hirsch we are indebted to our contemporary the *Illustrirte Zeitung.*

LOUIS KOSSUTH.

THE career of Louis Kossuth closed as it began, amid storm and patriotic excitement. While Kossuth lay on his deathbed, the national party in Hungary were using his name as a firebrand against the government, and his death produced a popular demonstration which has kept Hungary in a fever ever since. The national mourning has been genuine and sincere, for his long exile of forty-five years had not dulled the nation's gratitude. Nearly half Kossuth's life had been spent away from his native country, for he was almost ninety-two years old at his death. He was of Slavonian descent, and was born in 1802 at Monok, in the county of Zemplin, a rich agricultural district, where his father practiced as a lawyer. Young Kossuth was brought up to his father's profession. He first came into notice through his excellent parliamentary reports when sitting in the Presburg National Diet as representative of the absentee landlord Count Hunyady. These reports were published as a *Parliamentary Gazette*, and soon got Kossuth into trouble with the Austrian government when the young writer extended his reports to the Pesth Assembly. He was arrested, tried for high treason, and condemned to four years' imprisonment. Public feeling, however, was too much for the government, and Kossuth was released. Through the medium of his newspaper, the *Pesth Journal*, the first political organ in Hungary, Kossuth steadily worked for national independence with such success that when the revolutionary breeze of 1848 blew throughout Europe, the time was ripe for action. Kossuth, then leader of the Pesth Lower House, proposed the address to the Emperor Ferdinand, demanding Hungarian independence, and when the insurrection in Vienna had cleared the way he entered the capital in triumph to present the demand in person, and meet with a wildly enthusiastic reception. The Emperor granted a separate government for Hungary, and from that time Kossuth devoted his whole energies to developing the civil and military institutions of his beloved country. His work was hardly complete before the Croatians, led by Jellachich, revolted against Hungarian supremacy. By then Kossuth was disgusted with the weak Austrian sovereign, and threw off the lest vestige of allegiance when he called upon the Hungarians to rise in defense of their land. Then followed the struggle in which the Hungarian successes were rendered fruitless by the intervention of Russia. Thoroughly disheartened, Kossuth resigned his powers to Gorgey, and, when the latter surrendered to Russia, Kossuth fled to Turkey, only to be imprisoned and proscribed. Austria demanded his life, but, through English and American influence, the patriot was at last set free to find asylum in that general refuge of the destitute—England. Here he received ample hospitality and for several years remained in London stirring up his compatriots to maintain their lost cause. He was never to return to his country, for when the long desired constitution was given to Hungary and Emperor Francis Joseph was crowned king, Kossuth refused to share in the general amnesty and to be reconciled to the Hapsburg dynasty. For the last thirty years Kossuth lived in Turin, where he passed away on March 20, after a long illness. His death was the signal for a fresh outburst of political animosity. As the Hungarian government refused to accord state honors to Kossuth's remains, although willing to allow him to be buried at Pesth with all due ceremony, violent rioting broke out. The students led the way in disorder, preventing the theatrical performances and hoisting black flags, while the mob took the opportunity to loot and riot wholesale. Eventually the military quelled the disturbance, and Kossuth's sons telegraphed that they would not permit their father to be buried in Hungary if order were not restored. Then the students enrolled themselves as a "Guard of Order," and every preparation was made to receive Kossuth's body with great honors. The patriot's remains left Turin amid every sign of respect, and were taken to Pesth to rest by the side of his wife and daughter.—*The Graphic.*



LOUIS KOSSUTH.
Born 1802. Died March 20, 1894.

DUCK FATTENING IN ENGLAND.

AMONG the smaller rural industries of England that of rearing and fattening ducks is one of much interest, and also one that might be made of greater importance. In the country around Leighton Buzzard, in the counties of Beds and Bucks, this business has been pursued for a number of years, those engaged in it being chiefly cottagers. The accommodation required is not extensive, nor can the initial capital be large, at least so far as money is concerned, though the capital represented by time, trouble and careful attention must be far from insignificant.

The Aylesbury duck is the breed employed, and, as a rule, the ducks which are reared and fattened are not bred on the establishment. The custom is for the fattener to buy his eggs from people in the neighborhood and hatch them under hens. Some trouble is taken to secure an adequate contingent of sitting hens at the time the eggs are ready, and the people engaged in the business are fully alive to the advantage of getting the fat ducklings early to market. The game season ends in February, and from then to the reopening of the shooting season in August is the time when fat ducklings make their market. Prices are highest in February and March, being then from 14s. to 16s. a couple, and gradually decreasing to 5s. or 6s. in July, on the London market, the average dead weight of the birds being about 6 lb.; dressing to 4½ lb. After hatching out, the young birds remain for a week with the hen, and are well fed on boiled egg and other dainty morsels. With other birds of the same age they are then drafted into a "flock" of 100 to 125 birds. At this age they are exceedingly pretty objects—little animated balls of yellow down, with heliotrope colored bills and a plaintive chirp. As they get older the feathers become white and the bills grow paler. On a single duck "farm" numbers of flocks may be seen of one, two, three or more weeks old, and this classification is the only one adopted, as all the birds are destined to be killed at eight or nine weeks old.

Good rice, either Rangoon or stained Japan, at about 16s. a cwt., is the chief food of the younger birds and is boiled for use. They are also very fond of toast soaked in water. Later on barley meal and toppings, or sharps, are introduced; and when the birds are five weeks old they also get greaves or tallow scrap, which is boiled up in the food, into which stinging nettles

chopped and boiled are introduced, as they are said to cool the blood.

The ducklings are fed thrice a day—at 7:30 A. M., 12:30 P. M. and 4:30 P. M. They are never allowed to roam at will or to go on water, though a pail of water is allowed them for washing purposes. Special care is taken in securing suitable grit to go in the drinking water. The local gravel has no clay with it and will not bind, but suitable gravel can be bought at Long Marston at 1s. 6d. a load.

Recently a party of gentlemen interested in the subject visited the Leighton Buzzard district, among them being Mr. C. E. Brooke (master of the Poulters' Company), Mr. A. E. Brooke-Hunt, of the Board of Agriculture, Mr. Edward Brown, Mr. R. L. Everett, M.P., Mr. E. Glaisyer and Prof. Wallace.

At one of the farms inspected the party saw 2,000 ducklings at one view. Very commonly a low, warm shed, with a space of ground in front of it, was all the room the birds were allowed. By means of 12 in. planks placed edgewise the inside of the shed can easily be divided into rectangular compartments, each holding 100 birds; crowding is thus prevented. They are all let out in one big flock for feeding and exercise, but on their return they are penned off in the manner stated. On one of the smaller duck farms 1,800 birds were plucked last year; on the largest visited the number was 10,000. On this latter place it was computed that for every 100 birds hatched out 85 are ultimately marketed. Deaths are most frequent when the birds are very young. At the height of the hatching season as many as 200 or 300 hens will be sitting on one farm; clucking hens cost as much as 4s. each early in the season; but the price gradually falls to about 1s. 9d. By midsummer the whole stock of ducklings is cleared off, and there are none on the place till the earliest arrivals of the next season make their appearance. In the three or four months' interval the duck houses are cleaned, whitewashed and sweetened in every way. During the whole fattening season, however, considerable care has to be taken in keeping the surroundings healthy. Among the ailments of the birds is "soft bill"—so soft sometimes, it is said, that the young birds cannot break their way out of the shell. It is very probable that this evil is a result of too close breeding, and from observations which were made recently it would appear that a little technical instruction and a few investigations upon this and allied matters would be of considerable value to those engaged in this minor industry.

THE CLIMATIC AND NATIONAL ECONOMIC INFLUENCE OF FORESTS.*

IT is to German scientific men that we owe the first steps taken in order to ascertain data concerning the actual climatic effects of forests. Since then, however, most civilized countries except Britain, have been actively engaged in the collection of actual data concerning this very important subject. So far as those data have yet been collated and compared, they lead to the following results.

It was not until the year 1867 that exact scientific observations were undertaken on an extensive scale to determine the actual influence which forests have in modifying the temperature of the air and of the soil within their own areas and over the surrounding tracts of country, and the first results were published in Ebermayer's celebrated work, *Die physikalischen Einwirkungen des Waldes auf Lufte und Boden*, 1873.

1. *As Regards Atmospheric Temperature.* — The average results of observations made during ten years (1876-85) throughout nearly the whole of Germany, and in parts of France and Switzerland, in different kinds of forest, at heights above the sea level varying from 10 to 3,000 feet, and at latitudes varying from 47½° to 55¼°, prove conclusively that in general the annual average temperature within forests growing in closed canopy is lower than in the open, although the crowns of the trees are on the whole a little warmer in winter. The difference is greatest in summer, least in winter, and about midway between these extremes in spring and autumn; the mean annual difference, however, seldom amounts to over 1° Fah. near the ground, and is scarcely ½° in the crowns. The prevention of insolation of the soil during the long hot days of summer, and the rapid transpiration taking place through the foliage, exert a greater influence on the atmospheric temperature than can be ascribed to shelter from wind and to decrease of nocturnal radiation.

The observations recorded prove (1) that the variations between the temperatures of the trees themselves and the air in the open exceed those between the woodland air and the latter except during winter, (2) that they are largest during the most active period of vegetation in summer, and (3) that they are greater in spring, when the circulation of sap begins, than during the autumn months, when vitality becomes sluggish and dormant.

In the crown of the trees, where insolation by day and radiation by night make their full influence felt, the difference in the daily average over the whole year is less than it is near the ground. In winter it averages little either above or below 0°, and in summer usually about the half of the reading at 5 feet above the ground.

Observations made in Southern Germany establish the fact that in the forests it is cooler during the day and warmer during the night than in the open.

During the night the trees interfere with the radiation of heat, and in the day time the shade afforded by the crowns keeps the air from being rapidly warmed by the sun's rays. These influences are naturally strongest during spring, summer and autumn, when foliage is most abundant, while in winter the coniferous forests with evergreen foliage are milder than deciduous forests.

Owing to these differences in temperature, beneficial currents of air are induced between the forests and the open country, which follow the same law as obtains in regard to land and sea breezes. During the day the cooler and moister air of the forest sets outward to take the place of the heated air ascending in the open; at night the current sets in from the open, cooled by radiation, toward the forest.

* From *Nature*.

The statistics, upon which these deductions are based, prove that the immediate action of forests is to modify the daily maxima and minima of atmospheric temperature, whence it may be deduced that a comparison of the absolute extremes of temperature during the year must exhibit definitely the sum total of the influence exerted by forests on the temperature of the atmosphere. The modification of the extremes of temperature, which are bad alike for man and beast, and also for agricultural operations, is of immense importance from a national economic point of view, since many places that were once fertile are now little better than barren wastes in consequence of the reckless denudation of forests.

In registering the data, however, it was observed that the geographical position, and the exposure of the forests to winds, exerted a certain amount of modifying influence in lessening the differences, and there are reasons to believe that toward the crown the forest temperature in winter is considerably higher than down nearer the ground. It was found, too, that certain forest trees exerted greater influence than others in consequence of the density of their foliage; for beech forests in summer exert, through their dense foliage and complete canopy, a considerably greater influence in diminishing the extremes of temperature than forest of spruce or Scots pine, although after defoliation their influence is merely similar to that of the pine forest, and only half so great as that of the more densely foliaged spruce.

2. *As Regards Soil Temperature.*—The influence exerted on the soil temperature by forests growing in close canopy is of considerable importance, especially with regard to the soil moisture. The observations made concerning this point seem to make it clear that the mean annual temperature of the soil in the forest is at all the above depths of observation cooler than in the open, and that the differences are greatest in summer, about the mean in spring and autumn, and very small in winter. In countries with warm summers this reduction of the soil temperature over large areas by means of forest growth has a decidedly beneficial result. According to observations made in Wurtemberg, the difference between the maxima of soil temperature in forests and in the open can extend so far as up to 14° Fah.

It was also found that the daily differences in soil temperature varied according to the season of the year, but that throughout nearly the whole year the upper layers of soil in the open were warmer in the afternoon than in the forenoon, whereas in the forest the variations were inconsiderable.

As with regard to the atmospheric temperature, the influence of the forest trees in equalizing the soil temperature throughout the year is greatest in the case of trees whose foliage is densest, spruce heading the list.

3. *As Regards the Degree of Atmospheric Humidity.*—Observations recorded throughout Central Germany show that *as regards the absolute humidity of the air* forests have no appreciable climatic effect, for the annual averages showed merely slight traces of differences at 5 feet above the soil.

The differences between the relative humidity of the air in forests and in the open are, as might be expected, greatest in summer, although very different results as regards variations are obtained with changes of altitude and of other physical conditions.

The results of the various series of observations, corrected so as to eliminate, so far as possible, local differences due to altitude and other physical dissimilarities in the various meteorological stations, show that the mean annual relative humidity of woodland air is from 3½ to 10 per cent. greater than that of air in the open, but that the difference varies greatly according to the season of the year, being greatest in summer and autumn, and least in winter and spring. They show, too, that large areas covered with spruce will be moister as well as cooler than those under woods of less densely foliaged species of trees. In Bavaria it was found that in summer, in consequence of the density of the foliage in beech forests during the most active period of growth, the difference even amounted 13·6 per cent. of saturation over the relative humidity in the open.

4. *As Regards the Precipitation of Aqueous Vapor.*—It has been shown above, not only that the atmosphere within the forest is cooler than in the open, but also that the temperature of the trees themselves is lower, especially in summer, than the air surrounding them; hence, when a current of air is wafted from the open into the forest, and comes in contact with the cooler trees, its temperature is reduced, and it is brought nearer to the point of saturation, *i. e.*, its relative humidity increases. But if this air was already in the open at, or near, the point of saturation, then the effect of the cooling process is that a certain amount of surplus moisture beyond the aqueous vapor that can be held by the air up to a point of saturation at its reduced temperature must be released and precipitated in the form of dew. Woodlands, therefore, act as condensers of atmospheric moisture, and decrease the absolute humidity of the air while increasing its relative humidity; and, in addition to this, they increase the humidity of the air by transpiration from the leaves, while the sap is being rendered available for structural purposes, and the work of assimilation is proceeding.

Endeavors have been made to establish, by means of careful observations, the effect of forests in regard to the precipitation of aqueous vapor in the form of dew or rain, but the results are often of so conflicting a nature that, up till the present, safe deductions cannot be drawn. In order to compare observations made in the forests with those made at the usual meteorological stations in the open, a correction would in each case be necessary to reduce the localities to the same sea level, as air cools in rising and increases in relative humidity, *i. e.*, it approaches the point at which it must precipitate some of the aqueous vapor held by it. Hence rainfall generally increases with the height of a locality above the sea level, although no direct proportional increase can be proved. It fluctuates with the geographical position and the varying physical conditions of each point of observation, while variations in the direction of the moist winds of the locality also militate against the collection of reliable data for comparison with readings made in other localities.

The mean of the readings at 192 points of observation in Germany, corrected as carefully as possible with reference to these causes of difference, do not seem capable of giving any more exact inference than the general statement that at high altitudes large extents of forest may considerably increase the local rainfall. As regards the quantity of rainfall and snowfall which is intercepted in forests by the leaves, branches, and stems of the trees, the observations made in Switzerland, Prussia, and Bavaria show that nearly one-fourth of all the precipitations of aqueous vapor is intercepted by the forest trees, and is given off again by evaporation, or is gradually conducted down the stems to the soil. In lofty forest-clad regions the mechanical action of the rains on the surface soil is thus very much modified.

By means of their lower temperature, their greater relative humidity, and the mechanical obstruction they offer to the movements of currents of air, extensive forests act decidedly as condensers of the aqueous vapor contained in the atmosphere, and their influence in this respect is more marked at high altitudes and in mountainous districts than on plains or near the sea coast, where other physical factors come into competition with and modify it. Further data are still requisite to enable us to determine with anything like certainty that forests directly cause increase of precipitations irrespective of such local considerations as the ruling direction of winds and peculiarities of situation; the generally accepted dictum is, however, that in the vicinity of extensive forests the rainfall is greater than at other localities under otherwise similar physical conditions.

In portions of the Russian steppes, planted nearly fifty years ago, the inhabitants assert that the summer rainfall has considerably increased, and that the danger to crops from drought is not so great as formerly, while the villages are also protected by the forest from the violence of the winter storms.

In summarizing and criticising this point Prof. Endres, of Karlsruhe, remarks as follows:*

"The data furnished from tropical countries must be accepted with the greatest caution, and in any case they afford no conclusive deductions for European circumstances. Blandford reports from India (*Meteorological Journal*, 1888) that in an area of 61,000 square miles, which was formerly denuded of woodlands, but has been planted again from 1875, the rainfall has increased twelve per cent. since then. But H. Gannet (*Weather*, vol. v.) arrives at exactly the opposite conclusions for America, as his observations in the prairie region and in Ohio go to prove that the rewooding of a tract exerts no perceptible difference on the amount of the aqueous precipitations. Lendenfeld also tries to prove that the clearance of woodlands in Australia has resulted in a better climate and an increase in rainfall, as the soil under eucalyptus remains hard as stone and inabsorptive, while it is rendered lighter and more porous by grass. (*Petermann's Geog. Mittheilungen*, vol. xxxiv.)"

5. *As Regards Evaporation of Soil Moisture.*—The low temperature and the high relative humidity of the atmosphere in forests are unfavorable to rapid evaporation, which is still further reduced by the protection afforded to the soil against direct insolation and the action of winds. From observations extending over ten years (1876-85) in various parts of Germany and Austria, the following relation is shown between evaporation in the forests and in the open in the vicinity of the forests: the differences would probably be greater if comparisons had been made with places in the open that were far removed from the modifying influence of the woodlands.

	Water Evaporated.	
In the open	20·9 inches.	The practical importance of this will be seen when it is recollected that the mineral food in the soil can be taken up by the rootlets only in the form of *soluble* salts.
In the forest	9·5 "	
Lower in forest than in open by..	11·4 inches.	
Evaporation in forest expressed in percentage of that in the open..	46 per cent.	

It was also found that the amount of evaporation depended on the class of forest, thus:

Species of Woodland.	Percentage of Water.	
	Evaporated in the Forest.	Remaining in the Soil.
Beech	40	60
Spruce	45	55
Scots pine	42	58
Clearing for reproduction	90	10

In these statistics no account has been taken of the quantity of water given to the air by transpiration through the leaves; but this is not of essential importance, as such supplies of moisture are drawn by trees, except during the earliest stages of growth, from the deeper layers of soil and subsoil not immediately and directly affected by the aqueous precipitations on the surface. This may be less true of spruce than of other trees.

The action of forests, therefore, is to retain in the soil a large proportion of the rainfall or of the moisture arising from the melting of snows, which, by percolation to the lower layers and the subsoil, tends to feed

* Conrad, Elster, Lexis, and Loening's "Handwörterbuch der Staatswissenschaften," 1892, vol. iii., page 608.

the streams perennially, and to maintain a constant supply of moisture, without which trees could not derive their requisite food supplies from the soil.

The nature of the soil covering below the forest trees exerts also considerable influence on the amount of moisture evaporated. From experiments conducted during five years in Bavaria it was found that a good layer of fallen leaves, and of *humus* or vegetable mould formed by their decay, is a powerful factor; it diminishes the evaporation by more than half, or reduces, it to less than one-quarter of that in the open, and thus adds very considerably to the surplus amount of moisture retained in the soil.

6. *As Regards the Feeding of Streams and the Protection of the Soil.*—From the above data it seems evident that the effect of extensive forests, more especially of those situated at high altitudes, is, by cooling the air and reducing its capacity for retaining aqueous vapor, to increase the precipitations. While these precipitations are taking place the crowns of the trees intercept a large proportion of the total, and by breaking the violence of the rainfall protect the soil from the danger of being washed away during heavy storms. By the decomposition of fallen leaves and twigs a strongly hygroscopic soil covering is formed, capable of imbibing and retaining moisture with sponge-like capacity. Rapid evaporation of the soil moisture is counteracted through the protection afforded by the foliage against direct insolation during the day, and by the mechanical hindrance offered to currents of wind. The crown of foliage likewise prevents the soil cooling rapidly at night by radiation. The hotter the summer, the more marked are these beneficial effects of the woodlands.

When, therefore, large tracts of country are denuded of timber, increase of temperature during the days of summer, rapid radiation of soil warmth by night, diminished precipitations (especially in the spring and summer), and unchecked evaporation of moisture, due to complete insolation of the soil by day and absence of any protection from winds, must be the inevitable consequences. Examples of such actual results can be pointed out in many parts of continental Europe, in Western Asia, and throughout India. In Great Britain and Ireland the effects of the wholesale clearance of woodlands have not been so marked, in consequence of the favorable influences exerted on our climate by the Gulf Stream.

In localities having no protective woodlands heavy rains wash away the surface soil, torrents and freshets rush down the watercourses with great violence, laden with detritus and discolored with the soil held in mechanical solution, while streams and rivers often overflow their banks in consequence, devastating large areas of low-lying tracts under cultivation. Forests, on the other hand, tend to break the violence of the rainfall, and retain for the time being about one-fourth of the total amount on the foliage and branches; the roots of the trees and of the undergrowth help to bind the soil firmly; the rainfall is retained by the vegetable mould and by the spongy growth usually found on the surface soil, and thence gradually percolates to the deeper layers, where it is held in reserve, to be finally parted with in being utilized for the feeding of perennial streams having their sources on the wooded slopes.

Thus arose in the Alpine districts of southern Europe the necessity for maintaining *ban-forests* as a protection against landslips, avalanches, etc., and legal measures were early adopted for safeguarding them in order to protect the lower tracts from erosion of the soil when sodden with rainfall or melted snow.

7. *As Regards General Hygienic Effect on the Atmosphere.*—It is well known that on the one hand when large tracts of forests are cleared for cultivation, especially in tropical and subtropical countries, fever and ague are frequently the consequence, and on the other that the planting of notorious fever districts, such as the Campagna di Roma, the Tuscan marshes, and the Russian steppes, has decidedly diminished the insalubrity of these localities. But the causes are very probably rather due to the degree of direct insolation of the soil, freely afforded in the one case and counteracted in the other, than to any hygienic property inherent in tree growth. In the latter case, too, stagnating surplus of soil moisture may have been got rid of by transpiration through the foliage, and this would of itself go far toward removing causes of insalubrity, and improving the climate.

It is generally accepted that ozone kills miasma in the air, and purifies it; at any rate, impure air contains little or no ozone; the proportion of ozone is, therefore, usually taken as the measure of atmospheric quality. The belief that the woodland air is, like sea air, very rich in ozone, has not yet been satisfactorily proved. Experiments in Bavaria showed that in the forests the percentage of ozone, though greater than that in the vicinity of towns, was slightly less than in the open in the vicinity of forests, and that there was no perceptible difference in this respect between coniferous and deciduous forests.

The woodland air was found to contain most ozone in winter, which shows that its production could not be due to any chemical action of the foliage, for there are no leaves on deciduous trees at that season, while conifers transpire merely, and do not assimilate. It also indicates that the excess is probably due to the comparative freedom of air in the forest from the smoke, carbonic acid, and many other impurities with which air in the vicinity of towns is contaminated and defiled, and to the withdrawal of enormous supplies of oxygen from the air which takes place for the support of animal life at all populous centers. Thus, while in general the quantity of carbonic acid in the atmosphere is somewhat under four volumes in 10,000, that is the normal amount in London air; but in thick fogs this proportion is frequently doubled, and has been known to be more than trebled, or even to exceed fourteen volumes in the city.

Sunlight, however, has the power of decomposing carbonic acid in the presence of chlorophyl, the green coloring matter contained in foliage, the carbon being absorbed by the plant for its growth, and the oxygen set free. During darkness a contrary action takes place, oxygen being consumed by the foliage, and carbonic acid given off. As, however, particularly in the case of deciduous trees, which are in leaf only from April till October, the hours of light far exceed in number those of darkness, the general hygienic effect of trees in cities and towns—apart from their invaluable æsthetic influence—tends decidedly toward the purification of the atmosphere from excess of carbonic acid.

Ozone, again, is an allotropic modification of oxygen obtainable by passing a series of electrical discharges through it; hence it is more than probable that in forests in exposed localities, more especially those at high altitudes, where storms and electrical disturbances of the air are most frequent, a greater quantity of ozone must be generated in the atmosphere than in localities less subject to such powerful ozonizing influences.

Ebermayer, undoubtedly one of the greatest authorities on this subject, says:*

"In the middle of the great 'ozone factory,' which we must consider the forest to be, neither more oxygen nor less carbonic acid is offered to mankind for breathing than over large unwooded areas."

At another part of the same article he also adds:†

"From the hygienic standpoint, it is worthy of notice that, according to my examinations, the air in and immediately above the crowns, then that in the immediate vicinity of the forests, has more ozone than that in the interior of the forests, where a portion of the ozone is consumed by the decomposing foliage lying on the ground."

It appears, therefore, to be his matured opinion at present that while more ozone is found in forests than in the open—which the Austrian students of the subject deny, or, at any rate, are not yet prepared to admit without further observations and proofs—yet the decomposing matter covering the soil consumes the surplus, and often more than that, so that no difference can be established in favor of the forest air. In this withdrawal of ozone in excessive quantities from the air by decomposing vegetable matter, the unhealthiness of tropical jungles, and the prevalence of malaria at all the lower elevations within the tropics usually covered by woodlands, seem easily explainable.

According to Endres and to Fernow,‡ it is claimed that forests tend to resist the spread of epidemics, and to offer a bar to the progress of diseases like cholera and yellow fever.

Regarding the sanitary influence of forests, the latter states (*op. cit.* p. 21) as his summary that "(1) the claimed influence of greater purity of the air due to greater oxygen and ozone production does not seem to be significant; (2) the protection against sun and wind, and consequent absence of extreme conditions, may be considered favorable; (3) the soil connections of the forest are unfavorable to the production and existence of pathogenic microbes, especially those of the cholera and yellow fever, and the comparative absence of wind and dust, in which such microbes are carried in the air, may be considered as the principal claim for the hygienic significance of the forest."

Fortunately, there are not many infectious diseases the germs of which can be carried by water; as yet, only two are known with certainty, cholera and enteric fever. When outbreaks of these diseases occur in tropical countries, the infectious power of the germs is favored by warmth and moisture; moreover, when epidemic, these diseases usually break out in thickly populated towns and similar localities, where it is impossible to submit the soil moisture or the water supply to the filtrating action of belts of woodland.

8. *As Regards the Agricultural Productive Capacity of Neighboring Tracts, and the National Economic Effect on the Soil Generally.*—From an agricultural standpoint, a dry season is much preferable to a low temperature and excessive rainfall. In the former case the crops, although they may be somewhat scanty, are invariably of superior quality. A wet season may produce abundant crops, but they are generally of low quality.

With regard to the influence of forests on the aqueous precipitations throughout central Europe, Prof. Endres makes the following remarks:§

"The question whether woodlands can influence the rainfall is one of the most important from a national economic point of view. Even if this could be distinctly affirmed, the beneficial action of forests would only be established in the rarest cases, for throughout central Europe at present the number of too wet years exceeds that of dry years. *In districts where the rainfall is over 40 inches, any increase is undesirable.* ‖ For agriculture very dry years are on the whole less disastrous than extremely wet years. The precipitations of any district are influenced mainly by the position of the mountain ranges with reference to the cardinal points of the compass, by its elevation above sea level and its distance from the sea."

But, as the American investigations prove (*idem.* p. 13), "no influence upon the general climate which depends upon cosmic causes can in reason be expected from a forest cover. Only local modifications of climatic conditions may be anticipated, but these modifications, if they exist, are of great practical value, for upon them rest success or failure in agricultural pursuits, and comfort or discomfort of life, within the given cosmic climate. The same condition must be insisted upon with reference to forest influences upon waterflow, which can exist only as local modifications of water conditions, which are due in the first place to climatic, geologic and topographic conditions."

Even so early as in Roman times it was recognized that too great a clearance of woodland areas brought undesirable changes in the physical conditions of Italy, and affected the welfare of the inhabitants. That the destruction of the ancient forests throughout Great Britain and Ireland, to such an extent that only 3·8 per cent. of the totel area can now be classified as woodlands (*vide* Parliamentary Report on "Forestry," dated August 5, 1887), was not followed by such disastrous climatic changes as were occasioned by similar causes throughout the Landes, Syria, Asia Minor, Greece, Russia and many parts of India, we owe entirely to our insular position with its moist climate, and to the happy effects wrought by that portion of the Gulf Stream which reaches our western and southern shores.

Early in the present century, for example, the Agricultural Society of Marseilles reported that in consequence of the reckless destruction of the forests after the revolution of 1789:

"The winters are colder, the summers hotter, and the beneficial spring and autumn showers no longer fall; the Uveaune, flowing from east to west, rushes down in flood with the least rain, carrying away its banks and flooding the richest pasturage, while, for nine months of the year, its bed lies dry, owing to the drying up of the streams."

To a similar cause also Prof. Geffcken (in *The Speaker* of January 6, 1893) attributes the Russian famine of 1892 in the following terms:

"We speak of the deficit (in the Russian Budget) of 1893 as certain, and it is easy to show that it will be so. *The principal cause of the present dearth is the drought during the last spring and early summer, and this absence of rain is greatly due to the devastation of the forests.* The area formerly covered with timber was enormous, the woods belonging to the crown, to the great landed proprietors and to the village communities. But the means of transport were then so imperfect and costly that only in the neighborhood of large rivers did the felling of timber pay. This changed with the construction of railways and the abolition of serfdom; the former gave the possibility of selling with profit, and the peasants abandoned their woods to speculators for what they thought a good price, little thinking of the future; the larger proprietors followed their example; the purchase money was spent in drink and luxurious living, and no one thought of replanting. *Too late has the government issued a law for the protection of forests. Such a devastation going on for twenty years not only exhausts a source of wealth, but has also other bad consequences.* When the country is deprived of its trees, the earth is dried up and crumbles from the hills; the water coming down from heaven cannot be kept back, as is the case with the woods, which act as a sponge, but rushes in torrents into the rivers and disappears in the sea, and the consequence is a gradual diminution of the fertility of the soil and the disappearing of numerous brooklets and small rivers, to help the larger ones show a low water mark, which proves prejudicial to the navigation."

This view is confirmed by the special correspondent of the *Times* (*vide* article "Through Famine-stricken Russia" in issue of April 18, 1892), who writes:

"I have now traveled over most of the famine-stricken provinces, and I have been struck by the sameness of the picture. Everywhere reckless extravagance meets the eye, the forests have been cut away wantonly, the rivers are neglected, the climate is ruined."

Such also appears to have been the opinion of Major Law, Commercial Attache to the British Embassy at St. Petersburg, as expressed in his "Report on Agriculture in the Southeastern Provinces of European Russia," commented on in a leading article of the *Times* of September 17, 1892, in the following words:

"It is said that this gigantic natural tillage farm (*i. e.*, the 'black soil' region) was formerly hedged in by belts of forest, which served the twofold purpose of sheltering it from the desert winds and of increasing the humidity of the climate. It is certain that these forests do not now exist, and that the black soil country is often scourged by devastating blasts from the steppe, and not infrequently baked by prolonged droughts. The desert winds pile the snow in drifts in winter, which become the source of destructive torrents in the spring. In summer the same winds are so fierce and arid that in the space of a few hours they wither the corn as it stands, while, when they are laden with sands, they smite the soil with perpetual barrenness."

All writers, indeed, who have recently published views on this subject, seem agreed as to the main causes of the recent Russian famine.*

In order to obtain the full national economic benefits that are derivable from woodlands, the areas reserved as forests or planted up should be scattered over the face of the country as equally as possible. In all countries where the population is thin, and primeval forest is still to be found, measures with this end in view can easily be carried out without inflicting any apparent hardship on the existing community. But wherever danger from famine is apt to recur from time to time, it would at the same time seem to be worthy of consideration whether it would not be wise to expropriate tracts of the poorer and higher land here and there, and plant them up on a well considered scheme for the purpose of ameliorating the climatic conditions for man and beast in the future. J. NISBET.

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* "Hygienische Bedeutung der Waldluft und des Waldbodens," in vol. xiii. of "Forschungen auf dem Gebiete der Agricultur-Physik," edited by Prof. Wollny, 1890, p. 429.

† *Op. cit.*, p. 435.

‡ "Forest Influences," p. 172, 1893.

§ "Hygienische Bedeutung der Waldluft und des Waldbodens" in vol. xiii. of "Forschungen auf dem Gebiete der Agricultur-Physik," edited by Prof. Wollny, 1890, p. 607.

‖ This is a point of very great importance with reference to the proposals of Mr. Munro Ferguson, M.P. (*Contemporary Review* for October, 1892, pp. 521, 522), for planting up the Highlands of Scotland, and Dr. Macgregor's three questions in the House on the same subject on November 13, December 12 and December 19, 1893. For if there be already any tendency toward more rainfall during the summer months than is good for agricultural crops, an extensive increase in the acreage of woodlands in such vicinities is not desirable.

* See also the article on "The Penury of Russia" in the *Edinburgh Review* for January, 1893 (pp. 17-19), which may be said to contain a summary of the best opinions on the matter.

ON THE UPPER PENINSULA OF MICHIGAN.

By WILL FARRAND FELCH.

IT is now two centuries since civilized men first penetrated the vast solitudes of the Lake Superior region. The history of the early explorations, missions, and settlements is full of deep, romantic, thrilling, and sometimes tragic interest.

The site of Marquette was not prominent at an early day, but the city is now the metropolis of the Lake Superior region, having far outstripped her elder sisters in population, wealth, and business. For the first half of its progress Marquette was essentially French in all its characteristics.

The French Jesuits, with firm step and intrepid mien, facing dangers, suffering, and sacrifices, bore aloft the Christian cross and welcomed even torture and death with a calm resignation which distinguished the followers of Loyola. Their deeds and memories are embalmed in the pages of Bancroft and Parkman.

The arm of French power soon taught the savages the sacred character of the "Black Coats"—as the Jesuits were called to distinguish them from the "Gray Coats," or Recollets. The patience and perseverance of the missionaries overcame all opposition, and the Huron nation received the truth; but the

terrible Iroquois—the "Romans of the West"—came down upon the Hurons like wolves upon the fold; the Hurons were destroyed as a nation; some fled to Mackinaw and others to the Bay de Noquettes, near Escanaba, while others gathered around the standard of the cross established by Father Allouez at La Pointe in 1665. Driven thence by the Dakotahs, they were established by Father Marquette in 1671. When Detroit was founded, in 1701, many removed thither, and others to Sandusky, where they were known as Wyandottes.

Father Mesnard was selected as the first missionary to visit Lake Superior—the shores of "Gitchie Gumee" or "The Big Sea Water." The choice was a fit one. Alone, in 1660, he left the haunts of civilization, and put himself in the hands of savages, who treated the aged priest with coarse brutality, compelling him to ply the paddle and drag the canoe up foaming rapids, or carry it across long portages. Finally he was left barefooted, exhausted, without food or means of procuring it, on the shores of Lake Superior to die. After a few days, during which he subsisted on pounded bones and other refuse, they returned for him.

Here, amid every discouragement and privation, with no white brethren nearer than Montreal, Mesnard began a mission and said mass. We cannot linger over the story of want, famine, and cold, which came to them, making memorable this effort to establish the cross by the waters of "Gitchie Gumee." Longfellow has immortalized it in his "Hiawatha:"

O the long and dreary winter!
O the cold and cruel winter!
Ever thicker, thicker, thicker,
Froze the ice o'er lake and river,
Fell the snow o'er all the landscape,
Fell the covering snow and drifted.

O the famine and the fever!
O the wasting of the famine!
O the blasting of the fever!
O the wailing of the children!
O the anguish of the women!
All the air was sick and famished;
Hungry was the air around them;
Hungry was the sky above them;
And the hungry stars in heaven,
Like the eyes of wolves glared at them.

The next year the missionary was sent to the Bay de Noquettes, and started in August, 1661. While his attendant was getting the canoe over a portage he wandered into the forest, and was never seen more. Whether he was lost in the wood or struck down by a straggling Indian was never known. In 1665 came Father Claude Allouez, and soon after came Father Marquette, whose history is too well known to need extended mention. His grave, at Point St. Ignace, opposite Mackinac Island, is a point of historic interest.

It is probable that the French fur traders had penetrated the wilderness prior to the missionaries. The immense profits of this trade excited the cupidity of English traders in New York City, and for nearly a century the English spared no pains to gain control of the trade. The French, on their part, employed agents to go among the Indians in order to maintain an influence over them. One of these was Captain Duluth, who was stationed at Sault Ste. Marie as early as 1679. He erected a fort at La Pointe, and in 1686 the fort of Detroit, where Fort Gratiot now stands, at the foot of Lake Huron.

The knowledge of minerals was almost contemporaneous with the discovery of Michigan. As early as 1659–60 the Jesuits reported lead and copper on the shores of Lake Superior. The first attempt at mining was made after the conquest of Canada by the British. A Mr. Henry, in 1765–66, found at Ontonagon an abundance of virgin copper, and application was made to George III. for a grant of all the copper mines within sixty miles of Lake Superior. The grant was made, but never issued out of the seal office, as a company was formed of nobles and nabobs, headed by the Duke of Gloucester, and a company of miners came out in 1770, spending the winter at the Sault and at Point aux Pines, a few miles above. They built a barge of fifty tons capacity, and in May visited the "Island of the Yellow Sands," but found no gold, as they expected. They found copper and lead ore, and erected a furnace at Point aux Pines. But they found the mining impracticable, and soon came back. Thus ended the first systematic effort at mining, and nothing more was done until 1843.

When Michigan became a State, in 1837 the only settlement on Lake Superior within its bounds was at the Sault, which had a population of 368. In 1820 Schoolcraft described it as a place consisting of fifteen or twenty buildings occupied by French and English families. It is not more than twenty-five years ago since the first iron ore was taken from what is known as the Jackson location, at Negaunee, when less than half a ton was packed on the backs of mules and half-breeds to the mouth of the Carp, from thence in canoes on the St. Mary's River, and pronounced worthless on its arrival in Detroit. Less than a quarter of a century ago the district which furnishes one-third of all the iron ore in this country, furnishing ore for 150 furnaces, was an unexplored wilderness. Now the county of Marquette alone, which contains nearly all the iron mines, boasts of a population of over 25,000. It has an area of 2,176,000 acres.

As might readily be inferred, the most important manufacturing interest in the Lake Superior region is the smelting of ores. The attempt to establish iron manufactures was made under very discouraging circumstances, before anything had been done to develop the mines, and when it would have been next to impossible to get the iron to market. It succeeded only so far as to show the sterling qualities of the ores and the readiness with which they could be converted into blooms and pig iron.

The largest portion of the ore goes to Cleveland and Pittsburg, and into the coal fields of the Mahoning and Shenango valleys. About one hundred furnaces in Ohio and Pennsylvania use Lake Superior ore. The freight by water is only 50 cents a ton, even from Escanaba, while from Cleveland to Youngstown it is $1 and to Pittsburg $2.

The stocks of the iron mining and smelting companies are not in the market, the owners being perfectly satisfied to keep them, as they pay dividends when working. And now a word about the region about Marquette and throughout the county of the same name.

The city of Marquette is situated on Iron Bay—a gem compared to the Bay of Naples by many. The harbor is nine hundred feet above the level of the sea, and is alive with all manner of steam and sailing craft, which annually bear away over a million tons of ore. Listen to the continual rumbling of the ore trains as they swiftly follow one another through the heart of the city and out upon the great trestle docks, into the pockets of which they deposit their burdens, and from whence it is poured into the holds of vessels alongside. See, in front of the city and along the lake border, the blaze of great furnaces, roaring day and night, to reduce the ore for market. See, also, the extensive wharves, loaded with thousands of tons of coal and merchandise for home consumption. Then turn and behold the fair city itself, the growth of only a few years, with its fine red stone churches, elegant residences crowning the cliff, substantial banks, convenient schools, and, above all, its pure, bracing air. The stranger arriving in Marquette at night would have no difficulty in believing it a stirring business town. A lighthouse sits at the entrance of Iron Bay, at the end of a breakwater a thousand feet long studded with numerous lights. The piers are aglow with gas and electric lights, and every vessel has a lamp swaying in its rigging, while at the right and left of the bay two gigantic blast furnaces send forth a flickering but steady flame. Here are located the United States custom house, the United States land agency, two rolling mills, car shops, and roundhouses, while outside the city are a dozen tracks, each loaded with great trains of ore from the mines, numbering nearly a thousand cars. There are several banks, good hotels, a number of fine museums of curiosities from the vicinity, and busy stores, and saloons without number.

The people of Marquette are well favored with the grand in nature, hills and valleys encompassing it, the swift-flowing river, the expanse of lake and stretch of shore line, while opposite the bay is the famous Presque Isle, and forty miles eastward are the 'Pictured Rocks," well worth coming this far to see.

Bidding adieu to Marquette for a tour of the iron mines, the train toils up a steep grade from the lake level to the heights of the Iron Range, stopping at the three or four blast furnaces before reaching Negaunee, twelve miles distant, the site of the first iron mines discovered. South of the city is an elevation, called a mountain, where the hematite or the yellow ore is located. This ore is easily mined, readily shoveled, but of a lean nature—that is, averaging but 44 to 55 per cent. of iron.

Iron mining is conducted on the same principle as quarrying, and the veins in the hills vary in width, from an opening in which a man can stand to one which would contain a regiment, or a cathedral. The veins dip at regular angles generally, never perpendicular. At the first opening of a mine the ore is deposited in a "stock pile." As the mine progresses in depth inclined tramways are built, traversed by cars of boiler iron, shaped like a coal scuttle, called "skips." From these the ore is dumped into cars running on a trestle to the stock pile or to the railroad cars.

The miners work in gangs of three, and are paid by the cubic foot or fathom, by contract or by the ton The captain of the gang starts his drill into the face of the iron wall, into which it is driven by the sturdy blows of his stalwart helpers. When a number of holes are made a blast of giant powder completes the work. These blasts are made four times a day, and are very dangerous to life and limb, resulting in cracked skulls, broken limbs, sprains, and contusions. The miners are taxed $1 a month for doctor hire. They receive $1.50 to $1.80 per ton for mining hard ore, and some as low as $1. This is very cheap compared with what coal miners receive. Hard ore, suitable for Bessemer steel, brings $5.50, where it formerly brought $10 and $11 a ton; but the iron interests are slowly improving.

Ishpeming, three miles from Negaunee, contains the largest mines—the Lake Superior, Cleveland, New York, Barnum, and others. Beyond these towns lies Michigamme, and farther north the copper region is around Houghton, Hancock, and Ontonagon. The Minnesota Iron Company made a very remarkable discovery of iron ore in the Gogebic and Iron ranges, which extend from Ontonagon County to Ashland, Wisconsin. South of these ranges, in the Green Bay region, lie the Felch Mountain and Menominee ranges. The former is about forty miles from Escanaba, on a branch of the Northwestern Railway, and was named in honor of Ex-Governor Alpheus Felch, of Michigan, now living in Ann Arbor, who formerly owned the land hereabout. Here are located the Metropolitan, South Side, and other mines, near the neighboring villages of Felch Mountain and Theodore, while beyond them towers Felch Peak. The Menominee Range is on the division line between Wisconsin and Michigan, and is very productive. Here are located the Iron Mountain, Norway, Vulcan, and other mines. The outlet for all these mines is Escanaba, on Lake Michigan, which contains the three largest docks in the world.—*The Graphic, Chicago.*

HIGH TEMPERATURE THERMOMETER.

MESSRS. BALY AND CHORLEY have devised a high temperature thermometer, the novelty of which consists in the replacement of mercury by the singular liquid alloy of potassium and sodium. The boiling point of this alloy lies somewhere in the neighborhood of 700°, and its solidifying point is —8°, so that between these limits the liquid is particularly suitable for thermometric use.

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